



NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

THESIS

**PERFORMANCE METRICS FOR THE PROGRAM
EXECUTIVE OFFICE FOR INTEGRATED WARFARE
SYSTEMS 1.0 AND 2.0**

by

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June 2005

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**PERFORMANCE METRICS FOR THE PROGRAM EXECUTIVE OFFICE FOR
INTEGRATED WARFARE SYSTEMS 1.0 AND 2.0**

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Submitted in partial fulfillment of the
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ABSTRACT

There is an obvious need for performance measurement in U. S. Navy commands. Not only are performance metrics, or measurements, essential to tracking progress toward strategic goals, but as a publicly funded entity and holder of the public trust, the Navy has an obligation to efficiently and effectively use those public funds. Performance metrics are the guideposts to achieving efficiency and effectiveness. This thesis was designed to aid the Program Executive Office for Integrated Warfare Systems, a Navy Echelon II acquisition command, with a performance measurement project, deriving metrics for two of its seven major programs, IWS 1.0 and 2.0. Performance drivers were captured through interviews with key leaders in those two major programs. Those interviews were transformed into causal performance maps which depicted the interplay of the drivers and the outcomes they influenced. Performance metrics were then derived for those drivers and outcomes and arranged in a balanced scorecard format. The scorecards may be useful to the major program managers in monitoring the progress of their organizations toward achieving strategic success. Additionally, the metrics should enhance understanding of strategic direction by the rank and file of IWS 1.0 and 2.0.

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I. INTRODUCTION

A. BACKGROUND

Performance measurement came to the forefront of federal agency consciousness with the passage of the Government Performance and Results Act of 1993 by the United States Congress. President Bush and President Clinton before him both emphasized improved efficiency and effectiveness in the federal government through strategic planning and performance measurement. Controlling and measuring performance in the attainment of strategic objectives is an essential part of the Navy's plan to improve its capabilities over the long run.

Program Executive Office for Integrated Warfare Systems (PEO IWS) is a Navy Echelon III command involved in the acquisition of shipboard weapon systems. The primary role of PEO IWS personnel is to shepherd and manage weapon systems through the programming and acquisition process; they do not physically produce the weapon systems themselves. As such PEO IWS depends almost wholly on the experience and capability of its manpower; it is a knowledge based organization.

The command was established in 2003 in order to

...Provide the required discipline and coordination of the architecture and overarching interface principles to which our systems will be developed. This PEO will be responsible for all surface ship and submarine combat systems, missiles (except TRIDENT and TOMAHAWK), radars, launchers (except TRIDENT), EW and gun systems. This PEO will combine the combat systems software programs from the present PEO Subs, Carriers, TSC, EXW and Surface Strike. This PEO will also be responsible for coordinating all ASW warfare area programs across PEOs. ASW software development, including the annual submarine combat systems software update, will migrate to PEO IWS, facilitating optimal development of ASW software across platforms. PEO Subs will continue as the complimentary buy and build organization for the supporting components and torpedoes.

This realignment changes our focus from the current platform centered approach to a more integrated approach across all

combat systems. As the Navy moves to open systems architectures and highly integrated systems of systems, it is critical that those efforts have a strong, consistent focus.

(Deputy Assistant Secretary of the Navy 2003)

The command's creation was in response to the Chief of Naval Operations' vision for optimal alignment of Navy organizations in order to successfully implement his strategy embodied in SEA POWER 21. PEO IWS was faced with the real challenge of combining entities from five different commands, with five different cultures, into an effective single organization. This required the creation of an organizational structure, infrastructure, processes, and systems for achieving its mission. Another part of that organizational design challenge was creating a useful performance measurement system that could be used to indicate their progress toward strategic goals.

PEO IWS was subsequently organized around seven major program areas. These major programs, known as IWS 1.0 through IWS 7.0 are listed below.

- IWS 1.0 Integrated Combat Systems
- IWS 2.0 Above Water Sensors
- IWS 3.0 Surface Ship Weapons
- IWS 4.0 International Programs
- IWS 5.0 Undersea Systems
- IWS 6.0 Command and Control (Networks/Excomm)
- IWS 7.0 Naval Open Architecture

Performance measurement is a crucial tool to the major program managers within PEO IWS. If implemented properly, it has the potential to answer two questions of significant importance:

- Are we doing the right things?
- Are we doing the right things well?

B. OBJECTIVE

The purpose of this thesis was to observe strategy, goals and operations at PEO IWS 1.0 and 2.0 with the aim of recommending performance metrics that might be useful for the major program managers in determining how well their organizations are meeting their strategic objectives. IWS 1.0 and 2.0 were studied, and after analysis of collected data, recommended performance metrics were suggested.

C. RESEARCH QUESTION

1. Primary Research Question

- What are useful performance metrics for PEO IWS 1.0 and 2.0?

2. Secondary Research Questions

- What are the vision, mission, and strategy of PEO IWS and its chain of command?
- What current performance metrics are being utilized by IWS 1.0 and IWS 2.0?
- What guidance does the Navy leadership give regarding performance measurement?

D. SCOPE AND LIMITATIONS

1. PEO IWS 1.0 and 2.0

This thesis is limited to the two aforementioned major program areas at PEO IWS. These two major programs may have much in common with other major programs at IWS and within the Navy, but the thrust of this effort was to evaluate these two entities only.

2. Strategic Goals

The recommendations herein are limited to measures of effectiveness and efficiency in achieving strategic goals. It is possible to drill down to lower and lower levels of an organization, and create more specific and tactically oriented metrics. Measures are limited to those appropriate for the major program manager level at IWS 1.0 and 2.0.

3. Perspective

While there are many individuals and organizations with a stake in the outcome of the work performed by PEO IWS 1.0 and 2.0, this thesis was written from the perspective that its primary users would be the major program managers of those two units.

4. Limitations

Limitations imposed by distance have made close interaction more difficult than if the author had been collocated with PEO IWS. Additionally, the author's limited experience with Navy acquisition undoubtedly will surface occasionally in this thesis.

E. METHODOLOGY

This thesis attempted to derive useful performance metrics by leveraging the personal knowledge of IWS 1.0 and 2.0 leaders and managers, as well as leading literature in the field of performance measurement.

1. Tacit Knowledge

There are different sources for deriving what is important to the success of an organization. The primary source chosen for this thesis was to tap into organizational managers' tacit knowledge, or that knowledge known to the individual, but not usually recorded anywhere. Individuals may or may not realize the depth of their expertise, or the intricacy to which they understand their own organizations. Individuals' tacit knowledge, based primarily on experience and education, can provide a significant source of information about the organization's performance, particularly in knowledge-based organizations like PEO IWS (Ambrosini and Bowman 2002).

2. Interviews

Interviews were used to extract tacit knowledge from leadership within IWS 1.0 and 2.0. In accord with Spradley's *The Ethnographic Interview* (1979), questioning was conducted as informally as possible, with the hope of building a rapport with interview subjects so that maximum cooperation might be obtained.

The ultimate goal was to allow interview subjects to express what they saw as the drivers of performance within IWS 1.0 and 2.0 through observations, stories, and anecdotes.

3. Causal Performance Maps

The performance drivers and linkages among them were identified in each interview. Interview data were then translated into cognitive maps known as causal performance maps. A cognitive map is a representation of an individual's knowledge, experience, and point of view (Ambrosini and Bowman 2002). A causal map attempts to visually portray the cause and effect relationships among performance factors that affect a desired outcome.

4. Performance Metrics

After causal performance maps were created, reviewed, and edited by interview subjects, critical performance variables were identified and metrics were derived based on past research and performance measurement literature. Additionally, interview subjects were asked to give their recommendations for useful metrics.

F. ORGANIZATION OF THESIS

Following this introduction, Chapter II reviews leading research in the field of performance measurement. Chapter III presents collected data in the form of PEO IWS and Navy-wide strategic objectives and vision and causal performance maps. An analysis of the collected data is offered in Chapter IV, Chapter V presents recommendations and summary.

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II. LITERATURE REVIEW

A. WHY BE CONCERNED WITH PERFORMANCE MEASUREMENT?

1. Government Performance and Results Act of 1993 (GPRA)

In January 1993, Congress passed GPRA in order to:

- (1) improve the confidence of the American people in the capability of the Federal Government, by systematically holding Federal agencies accountable for achieving program results;
- (2) initiate program performance reform with a series of pilot projects in setting program goals, measuring program performance against those goals, and reporting publicly on their progress;
- (3) improve Federal program effectiveness and public accountability by promoting a new focus on results, service quality, and customer satisfaction;
- (4) help Federal managers improve service delivery, by requiring that they plan for meeting program objectives and by providing them with information about program results and service quality;
- (5) improve congressional decision-making by providing more objective information on achieving statutory objectives, and on the relative effectiveness and efficiency of Federal programs and spending; and
- (6) improve internal management of the Federal Government.
(Government Performance and Results Act 1993)

Additionally, GPRA required that federal agencies incorporate and report to Congress the results of their strategic planning, including a mission statement, outcome-related goals and objectives, an analysis of how the goals and objectives would be achieved, and a description of how performance goals relate to strategic goals and objectives. Since public organizations do not operate to maximize profits, much of the efficiency derived from competitive markets was generally not being observed in federal agencies. Congress was attempting to improve efficiency and effectiveness by mandating practices that were common in private-sector enterprises, while also increasing the accountability of public

agencies. Performance measurement against strategic goals and objectives was deemed a key ingredient in improving public agency performance.

2. President Bush's Management Agenda

In his fiscal year (FY) 2002 Management Agenda, President Bush articulated management improvements that he sought to execute throughout the federal government. These improvements were to be "results oriented" and to "achieve immediate, concrete, and measurable results." Additionally, it was stated that subsequent goals would be undertaken as "tangible improvements are made." The President planned to formally integrate performance review with budget decisions, stipulate that agencies pinpoint outcome measures and accurately monitor the progress of their programs, and that the entire Executive Branch management become more performance-oriented. It was very evident that the President's agenda could not be achieved without robust and accurate performance measurement.

3. Department of the Navy

Performance measurement is a significant tool in the Secretary of the Navy's plan for improving efficiency and effectiveness within the Navy. It was a major theme in the Secretary's FY 2006/2007 budget submission to the Secretary of Defense, comprising nearly one-tenth of the total verbiage. In his "Principles of Leadership," the Secretary encourages Navy leaders to "incorporate measures and metrics everywhere." (England 2003).

Likewise, the Chief of Naval Operations specifically mentioned metrics thirteen different times in his "Guidance for 2005," his specific vision and goals disseminated to the entire Navy. The implication is that the Navy has specific strategic goals, and it cannot tell how well it is achieving those goals without specifically measuring its performance.

B. CYBERNETIC FEEDBACK MODEL

One of the most basic models of organizational function is the inputs-process-outputs model. In this model, organizational functions are broken down

into inputs to the process, processes that perform some transformation of the inputs, and outputs that are the result of the transformation. The organization exists to produce outputs. The leaders and members of the organization direct their efforts to the transformation of inputs for the delivery of outputs.

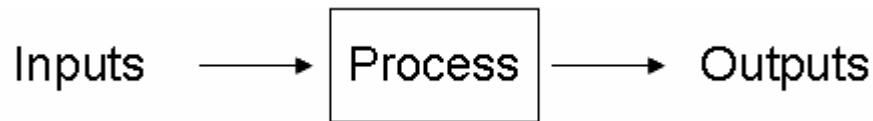


Figure 1. Inputs-Process-Outputs Model (From: Simons 2000)

A significant improvement on this model is the cybernetic feedback model. The cybernetic feedback model incorporates a standard or expectation for the output and a feedback loop. The standard allows the organization to define an acceptable output and the feedback loop indicates to leadership whether the processes are producing outputs that meet the predefined standard. This comparison of output versus an expectation is the hallmark of performance measurement systems. Variance from the standard is fed back to members and leaders of the organization so that they can alter inputs and processes in an attempt to better meet the standard. Thus, the goal of performance measurement is to direct and control organizational energy toward a desired outcome through systematic measurement.

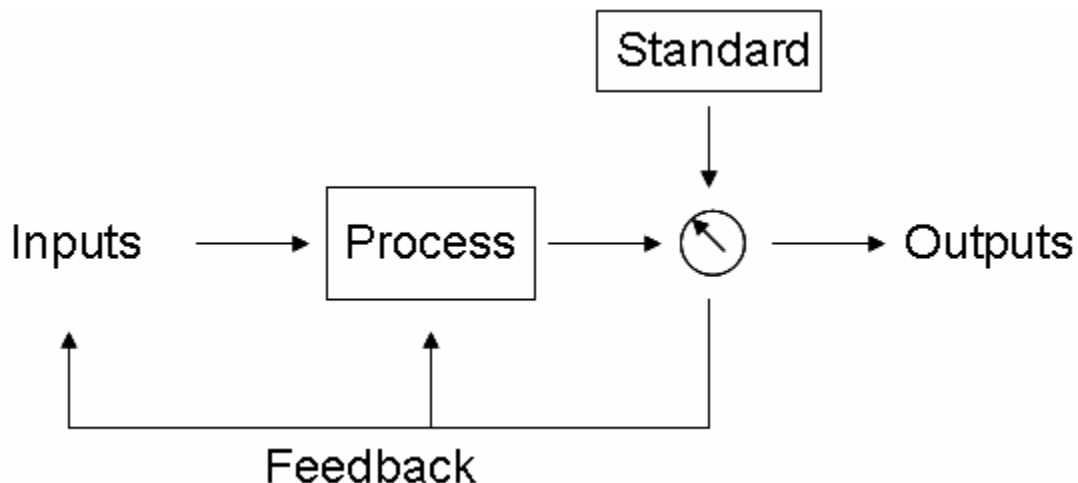


Figure 2. Cybernetic Feedback Model (From: Simons 2000)

C. THE NATURE OF PERFORMANCE METRICS

Modern researchers (Kaplan and Norton 1996, Lynch and Cross 1995, Simons 2000, Malina and Selto 2001) have taken a detailed look at performance measurement systems, both their derivations and characteristics, over the last three decades. Some of the common themes that emerge from the research of the last decade include:

1. Performance metrics should be linked to strategy.
2. Performance metrics should be focused on what is important to the success of the organization
3. Effective metrics have common traits.
4. Targets should provide actionable feedback to leadership and organizational members.
5. Performance measurement should integrate and unify the organization.

1. Strategic Orientation

Performance metrics should provide a snapshot of organizational execution relative to strategy; they should reflect progress toward achieving the organization's game plan (Lynch and Cross 1995). Long-term, strategic focus is easily overlooked within federal agencies, including the Department of the Defense, due to the short-term nature of funding profiles, to obligation and expenditure rates reviewed multiple times during the year, and to the immediacy interjected by unplanned contingencies. A reactive mindset can become engrained due to short-notice reporting requirements regarding financial standing and organizational accomplishments (Lynch and Cross 1995). Appropriate metrics should help maintain a strategic focus in the midst of a volatile operating environment.

2. Critical Performance Variables

In designing performance metrics, organizations must focus on what is imperative to their strategic success, to the exclusion of things that are not important. These important elements are known as critical performance variables (CPV). Getting the CPVs right is arguably the most important part of

determining useable performance metrics. The adage, “What gets measured gets managed,” applies. If what is truly important to strategic success is not measured, and less important factors are, then the result will be the diversion of management attention toward the less significant factors. One way to determine CPVs is to visualize where the organization wants to be five years hence, and if at that time the organization’s strategy had failed, what factors would have led to that failure. The factors that were important enough to have caused the strategy to fail are CPVs (Simons 2000).

Performance metrics should have a long-term perspective and be indicative of how the organization provides value to its customers. They should be balanced and focused on more than just products and financial outcomes by including non-financial measures (Lynch and Cross 1995, Kaplan and Norton 1996, Simons 2000). If all aspects of the strategy are not measured, only those parts that are measured are likely to get significant management attention. Balance is particularly important for knowledge-based organizations like PEO IWS because intellectual capital is not captured well in financial metrics. Kaplan and Norton identify four perspectives for balance:

- Financial Perspective - the economic impact of decisions
- Customer Perspective - factors that are critical to customers remaining loyal and satisfied
- Business-Internal-Processes Perspective - internal processes that are critical to the organization achieving its strategic objectives
- Learning and Growth Perspective - identifies the infrastructure (people, systems, and procedures) that will enable long-term growth and continuous improvement

Performance metrics should not only reflect the CPVs; they should be causally linked and mutually reinforcing (Kaplan and Norton 1996). The CPVs can be thought of as the organization’s story of success. Kaplan and Norton sum it up by emphasizing the importance of focusing on drivers of future performance: the cause-and-effect variables, which link actions to outcomes. Performance metrics can measure CPVs or the desired outcomes themselves. This will result

in either leading or lagging indicators of success, respectively. A mix of the two is desirable (Kaplan and Norton 1996). Simons further commented on factors involved in choosing what to measure.

- Measure inputs when it is impossible to measure processes or outputs, when the cost of inputs is high relative to outputs, and when quality and safety is important.
- Measure processes when they are observable and measurable, the cost of measuring them is low, standardization is critical, cause and effect relationships are understood, and it can result in strategic advantage.
- Measure outputs when they are observable and measurable, cost of measuring them is low, cause and effect relationships are not well understood, and freedom to innovate is desired.

Choosing the right thing to measure can save time, effort and money.

3. Desired Characteristics of Performance Metrics

Regardless of what is measured, the metrics should share some common characteristics. They should be actionable, measuring items that are within the manager's ability to influence. The information provided by metrics should be accurate and unambiguous. Metrics should capture the essence of a CPV. Simon's summed up the attributes of a good measure; it should be objective, complete, and responsive.

- Objective – quantifiable and measurable with confidence in accuracy.
- Complete – capture all relevant data in a manner that is understandable to users.
- Responsive – actionable by managers and leaders; within their sphere of influence.

Another way to think of the attributes of a good performance metric is with the acronym SMART (Harbour 1997).

- S – specific
- M – measurable
- A – actionable
- R – relevant
- T – timely

This list introduces the concept of time. Timeliness can be critical to the impact of a manager's actions. If a situation requires immediate attention, but the manager does not become aware of the variance from the performance standard until 30 days later, that is problematic. Those are 30 days of potentially wasted organizational effort moving in an unintended direction.

4. Tool for Management Action

Performance metrics are nothing if not a mechanism for management action. To function in this manner, metrics must be compared to some benchmark to indicate progress. As indicated by the cybernetic feedback model, the metric is compared against the standard to provide feedback to improve inputs or processes. Performance measurement provides a systematic process for tracking progress and making midcourse corrections; a regular opportunity for strategic review (Lynch and Cross 1995, Kaplan and Norton 1996). Because metrics focus on things management can influence, they direct attention toward what can be improved and away from what is beyond the manager's control. Feedback, particularly when communicated throughout an organization, provides an excellent chance for organizational learning and improvement. In that way, a well-designed measurement and feedback system can be the catalyst for continuous improvement and strategic development.

Appropriate performance metrics should help an organization achieve a higher return on management (ROM) (Simons 2000). ROM is equivalent to the amount of organizational energy released divided by the amount of management time expended. The goal of good performance measurement would be to allow leadership to manage by exception when practical, so that they can focus energy on issues and processes that need their continual expert attention. By allowing business processes to operate without continual management attention, the denominator of the ROM ratio is minimized, thus increasing the value of ROM.

5. Performance Metrics as Organizational Unifiers

By integrating metrics derived from strategy, the performance measurement system can effectively communicate the chosen strategy throughout the organization, align and link individual, department and corporate

goals, and identify and align strategic initiatives (Lynch and Cross 1995, Kaplan and Norton 1996). The right metrics should let employees see how their actions contribute to the performance of the whole organization (Lynch and Cross 1995). Individual employee connection to the entire organization's performance should act as a motivator, particularly when overall performance benefits individuals, uniting the organization around strategic goals. The performance measurement system serves to coordinate resources throughout the organization in line with corporate vision, potentially reducing redundancy and improving effectiveness and efficiency. When coupled with a good internal communication system, it also provides an opportunity for bottom-up strategic feedback from the elements of the organization that are frequently in closest contact with the customers.

III. COLLECTED DATA

A. STRATEGIC OBJECTIVES

One of the primary factors that might influence the success of a performance measurement system is how well metrics are linked to strategy. In order to arrive at performance metrics for IWS 1.0 and 2.0, the strategic environment in which they operate must be understood. PEO IWS reports directly to the Assistant Secretary of the Navy (Research, Development, and Acquisition) (ASN (R,D&A)) in acquisition matters, and to the Commander, Naval Sea Systems Command (NAVSEA) for matters pertaining to in service support (Department of the Navy 1995). NAVSEA subsequently reports to ASN (RD&A) and the Chief of Naval Operations (CNO). ASN (RD&A) and the CNO report to the Secretary of the Navy.

1. The Secretary of the Navy

The Secretary's strategic goals were spelled out in the Department of the Navy's FY 2006/2007 budget submission to the Secretary of Defense. They include maintaining a ready and sustainable force to meet today's challenge, investing in tomorrow's capabilities, and establishing processes and organizations that make effective and efficient use of our scarce resources. These goals are supported through four pillars of effective military power.

- People
- Combat Capability
- Technology Insertion
- Improved Business Practices

2. Chief of Naval Operations

The CNO has five stated strategic objectives in his 2005 guidance to the Fleet.

- Win the Global War on Terror (GWOT).
- Improve readiness for global response.
- Integrate Sea Strike, Shield Basing and FORCEnet into the Joint Force.

- Capture funds through Sea Enterprise to recapitalize the Navy.
- Develop the 21st century workforce.

He also has five long standing strategic priorities which have shaped the Navy during his tenure.

- Current readiness
- Future readiness
- Alignment
- Quality of service
- Manpower.

3. Assistant Secretary of the Navy (Research, Development and Acquisition) (ASN (RD&A))

The ASN (RD&A) guidance for 2004 included the following strategic objectives (PEO IWS 2005).

- Improve warfighter satisfaction
- Shape and train an effective acquisition workforce
- Lower total ownership cost of equipment and services
- Reduce cost and cycle time
- Accept responsibility as stewards of the national interest
- Personally change and improve the neighborhood every day!
- Consider all solutions – high tech to simple, commercial-off-the-shelf to military, U. S. to international

4. Naval Sea Systems Command

The NAVSEA guidance for 2005 contained the following objectives.

- Human capital strategy – continue to refine and implement
- Lean Implementation Plan – strive for efficiency while improving effectiveness
- Capture Cost Reduction – capture cost savings from increased efficiency to return to corporate Navy and customer accounts
- Improve and Measure Productivity
- Virtual SYSCOM

5. PEO IWS

PEO IWS identified areas for strategic success during strategic planning meetings at the beginning of FY 2005 (PEO IWS 2005).

- Personnel – optimum staffing, quality of work force, quality of life for employees, and refine human capital and horizontal integration strategies
- Programmatic – accurately manage cost, schedule, technical/performance, and risk and achieve success in development of Open Architecture, CGX Radar, and Active Missile
- Business – proactively manage all aspects of the budget process
- Fleet Readiness – support the ultimate customer

Figures 3 and 4 depict the goals and perspectives listed above in alignment from SECNAV down through PEO IWS. PEO IWS is depicted in its two separate chains of commands. If performance metrics within PEO IWS 1.0 and 2.0 are to contribute to organizational success and mission accomplishment, it is important that they support PEO IWS strategy and the other strategies in their chain of command. In this way the actions at the major program level within PEO IWS should impact the entire enterprise strategy in a positive manner. It is apparent that the different strategic objectives are aligned and support one another in achieving the ultimate goal of effective military power. The lines connecting the various goals and perspectives are the interpretation of the author.

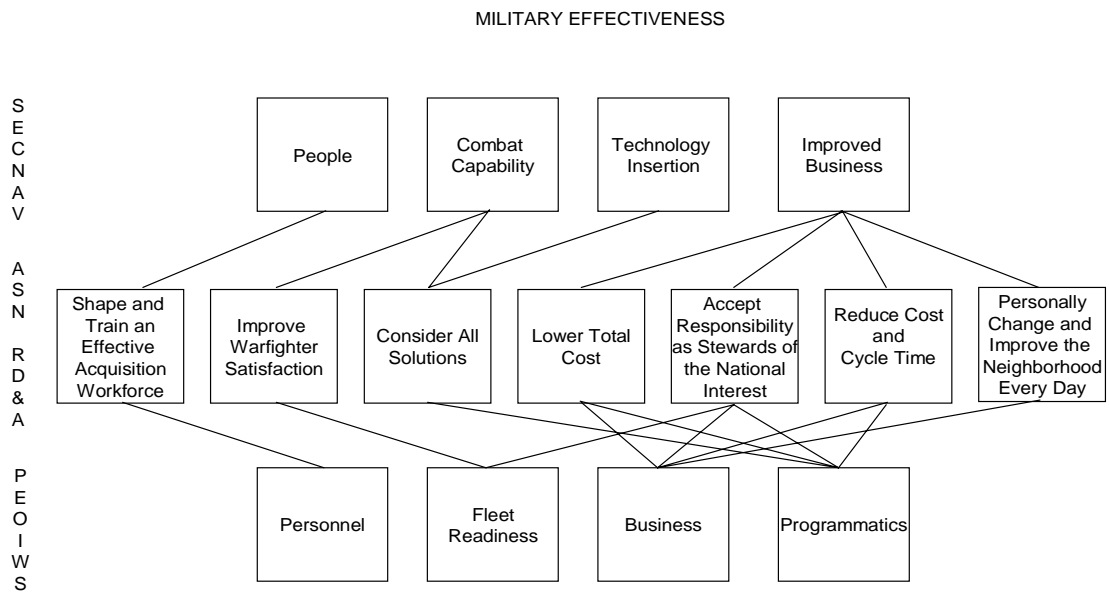


Figure 3. Strategic Alignment of PEO IWS Perspectives

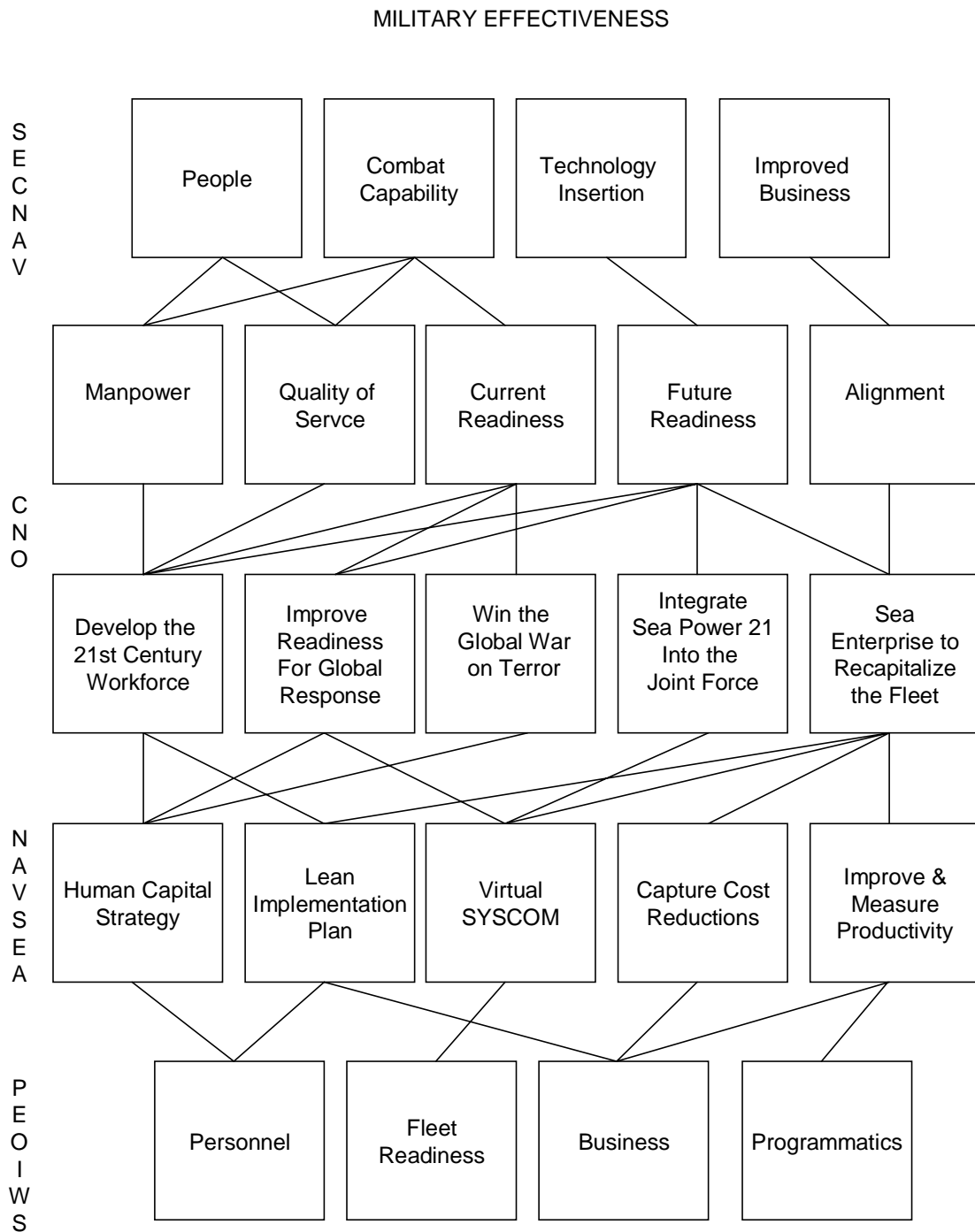


Figure 4. Strategic Alignment of PEO IWS Perspectives

B. PEO IWS 1.0 AND 2.0 MISSION AND FUNCTION

The primary mission for PEO IWS is to provide the United States Navy technically superior warfighting capability to take the fight to the enemy and win. Within PEO IWS, IWS 1.0 and 2.0 contribute to the accomplishment of that mission by providing top-quality integrated combat systems and above water sensors, respectively. Neither IWS 1.0 nor 2.0 physically produce weapon systems. Instead, they contract both Navy engineering field activities and private defense contractors to produce those systems. IWS 1.0 and 2.0 provide “cradle to grave” service to the warfighter from concept refinement through system disposal to ensure the Fleet has the needed weapons systems to execute their missions.

With that in mind, three middle to upper level leaders/managers at both IWS 1.0 and 2.0 were interviewed with the goal of defining what success looked like for their organizations, and also determining what factors influenced achieving that vision of success. An attempt was made to avoid leading questions in an effort to let the interviews reflect the feelings of the interview subjects alone. From those initial interviews, causal performance maps were constructed for each interview. Those maps were then presented to the interview subjects to modify as they felt necessary to best tell their story of how to achieve organizational success. Through this process of interview and subsequent refinement, causal performance maps became more accurate from the perspective of individual interview subjects. The interview subjects were not asked to critique each others’ inputs, only to concentrate on their own perspectives as to what were the drivers of success for their major program area.

Subsequent to the editing of individual maps, one composite map was developed for IWS 1.0 and one for IWS 2.0. This was done by combining the separate maps within each major program area. Where differences existed between maps, an attempt was made to resolve the difference through further communication with the interview subjects. If consensus was not feasible then both versions were included in the composite map. Since these maps are to be used to derive recommended useful performance metrics, it was important to

capture multiple points of view to get as whole a picture as practicable. Some consolidation of similar variables was required to make the maps less cluttered and more comprehensible, but effort was made to maintain the intent of the original subjects' maps.

C. INTERVIEWS

Six subjects within IWS 1.0 and 2.0, three from each major program, were selected to be interviewed based on their broad acquisition experience. The six subjects had a total of 112 years of either military or acquisition experience. Additionally, all were in positions within IWS 1.0 and IWS 2.0 to have detailed knowledge of both strategic direction and day-to-day operations. Five of the subjects were Government Service employees and one was a Naval Officer. Due to demands of the individual subjects' work and travel schedules, and limitations in the author's availability to travel, two of the subjects were initially interviewed together. Those two were subsequently asked to critique the resultant causal performance map independently.

The subjects were interviewed using the protocol depicted in Table 1. They were asked to define what desired outcomes translated into organizational success for IWS 1.0 or 2.0, respectively. The interview subjects were next asked to lead the author through the chain of cause and effect processes and inputs that would result in the previously identified desired outcomes. The subjects' responses were then analyzed to identify the significant variables that would influence the desired outcomes. Those variables and how they interact with one another were then depicted in the causal performance maps.

1. Record time, place, and identity of interviewee.
2. Indicate that the interviewee will remain anonymous and record consent to being recorded.
3. Could you describe your current position and work at IWS?
4. What is the mission of IWS 2.0 (or 1.0, as appropriate)?
5. Does your unit have overall goals?
6. Please describe what would be considered a good performance outcome for your unit?
7. If you could tell a story about how your unit can succeed, what would that story be like? Can you tell that story?
8. What factors are most important in determining whether your unit meets its goals, achieves good performance, or meets performance targets? Possible follow-up examples:
 - A. People investments (training, education, etc)
 - B. Financial efficiency (Waste)
 - C. Technical performance of new systems (Quality)
 - D. Supportability of new system
 - E. Delivery of new systems (Delivery)
 - F. Time efficiency, time to complete tasks (Cycle time)
9. Are these factors linked in any way?
10. Can these factors be measured?
11. Would any of these measure help you manage your organization any better to achieve success?
12. Now look out five years, are any other factors critical to IWS' success?
13. Who are your unit's customers, internal and external?
14. Do you get feedback on their satisfaction?
15. What is the biggest indicator of failure for IWS?

Table 1. Initial Interview Protocol

1. Causal Performance Maps

The maps that resulted from the interviews with IWS 1.0 and 2.0 subjects are depicted in Figures 5 through 11. The interview subjects are identified as Subjects A through F for the purpose of anonymity. Outcomes, the definition of success, appear on the right side of each diagram with factors that lead to that outcome appearing to the left. Arrows show the causal links between inputs, processes, and outcomes. Double-headed arrows indicate that factors influence each other. Terminology has been standardized to the maximum extent without disturbing the intent of the interview subjects.

Figure 7 is a composite map for IWS 1.0 derived from combining the causal performance maps of the different IWS 1.0 subjects. Figure 11 is the composite map for IWS 2.0. The maps can be difficult to interpret, largely due to the many lines indicating causal relationships. One of the main take-aways, which are relatively easier to identify, are the CPVs themselves. As stated earlier, getting the CPVs right can be one of the most difficult parts of determining performance metrics. It should be noted that some variables from the individual maps have been combined to enhance the readability of the composite maps.

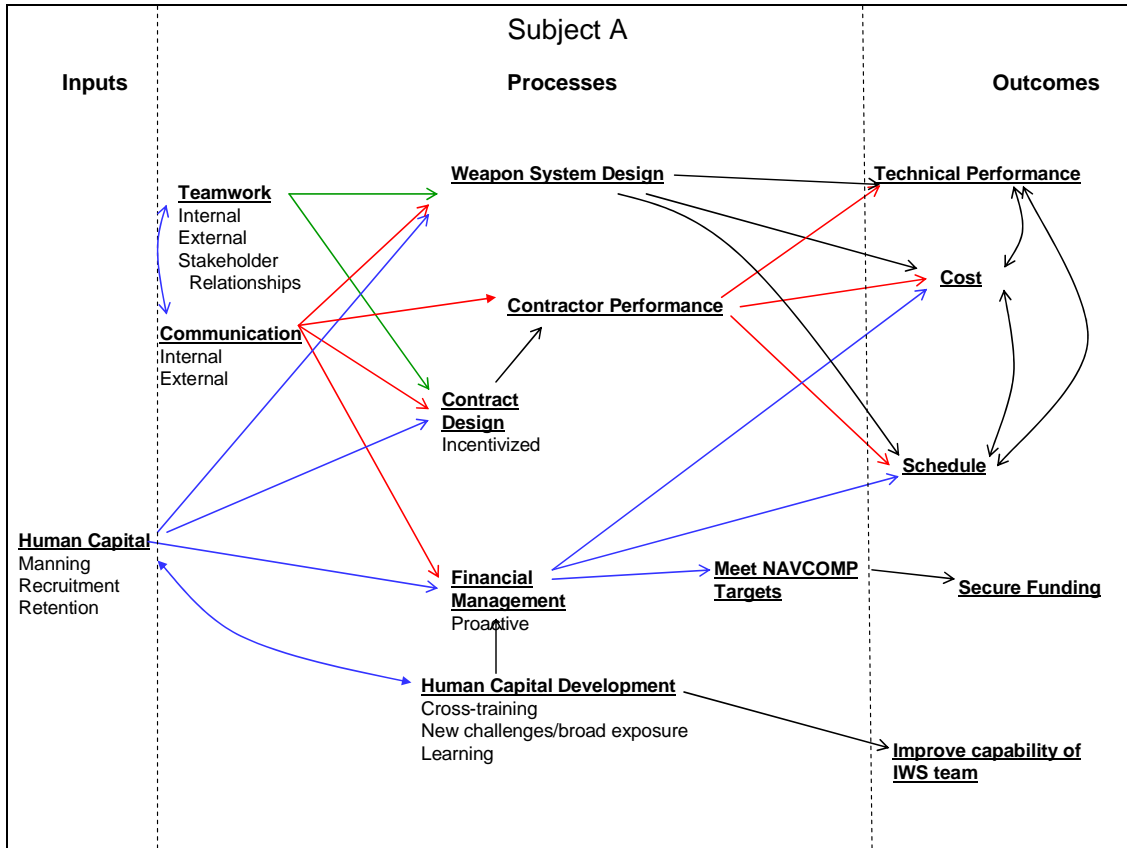


Figure 5. Causal Performance Map - IWS 1.0 Subject A

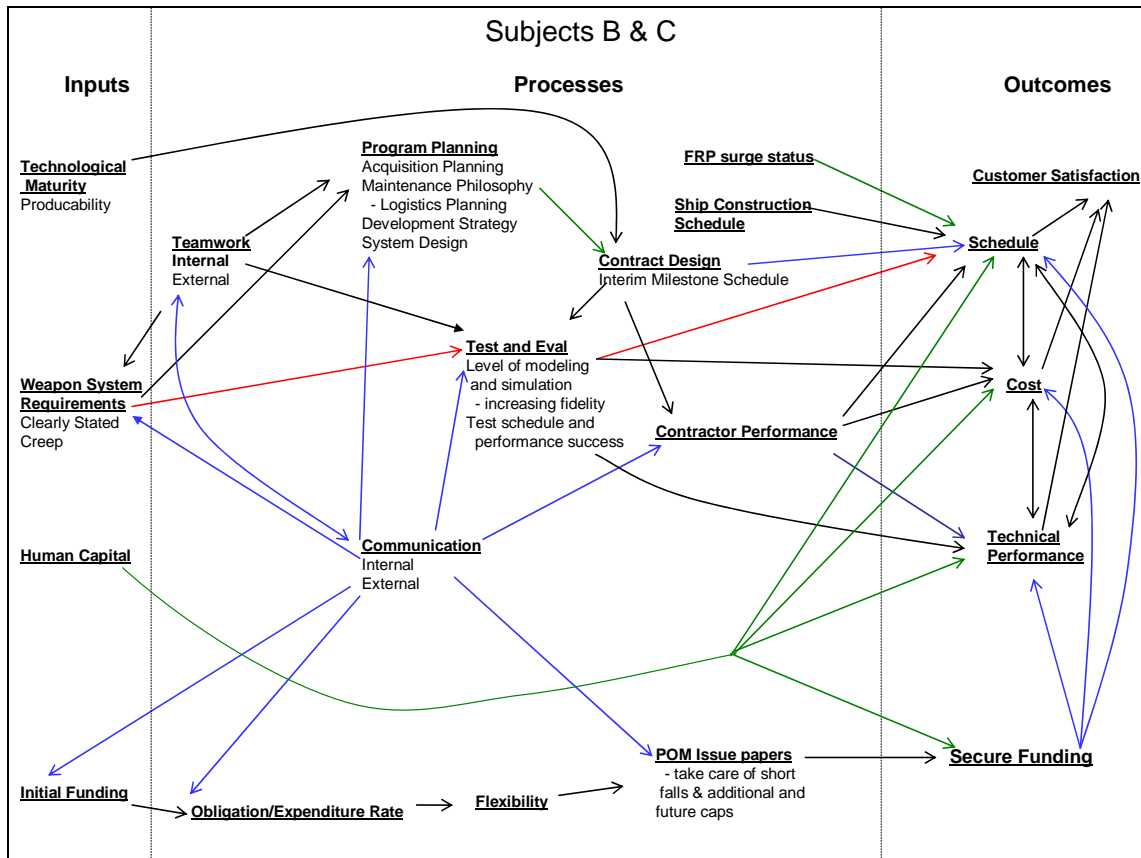


Figure 6. Causal Performance Map – IWS 1.0 Subjects B and C

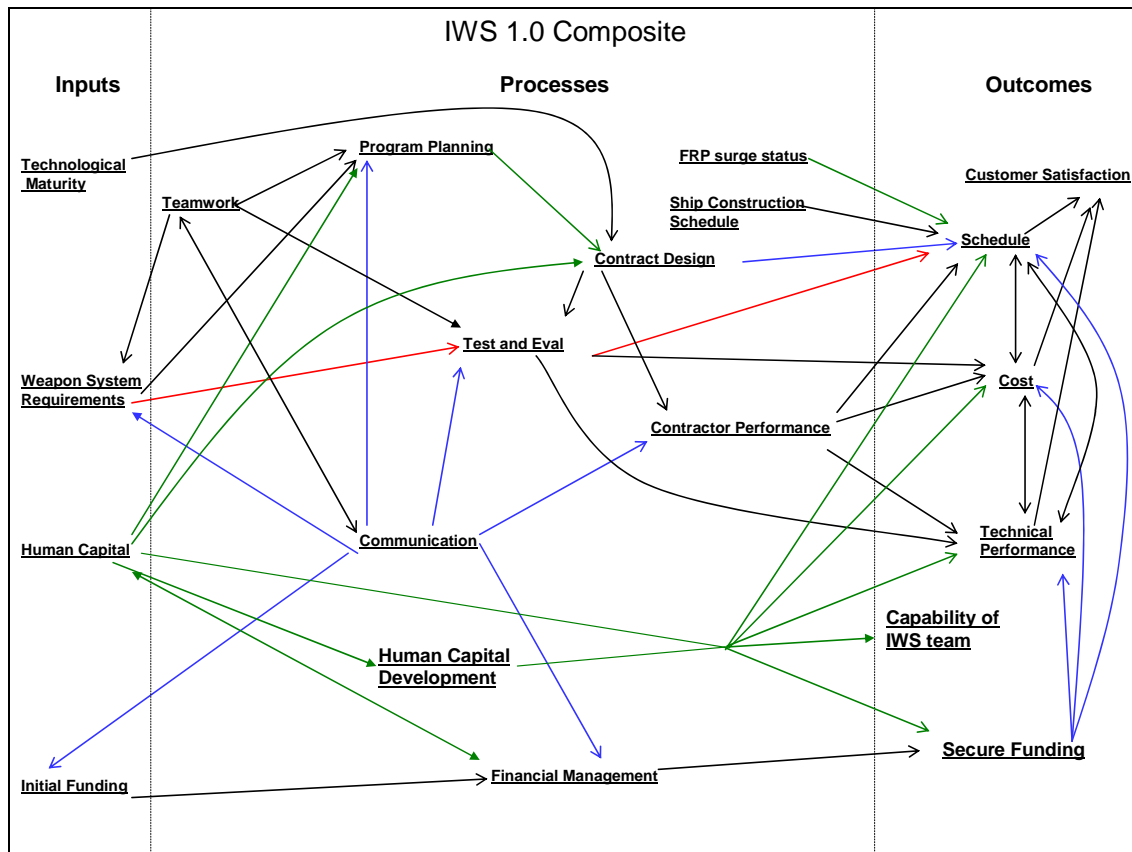


Figure 7. Causal Performance Map – IWS 1.0 Composite

a. IWS 1.0

(1) Outcomes. Figures 5 through 7 are relevant to IWS 1.0, with Figure 6 being the map produced for two interview subjects who were interviewed together. The outcomes that defined success were slightly different for the two maps, but both included the military acquisition standards of cost, schedule, and technical performance. Of note, supportability of deployed systems was viewed as a subset of technical performance within IWS 1.0. Additionally, they indicated it was critical to maintain the funding stream for current programs. If the major program manager, IWS 1.0, could end a hypothetical period with all programs on schedule, on budget, meeting technical/performance requirements, and have a secure source of funding that would be a successful outcome from the perspective of those interviewed.

Subject A also included the improvement of the IWS 1.0 team as a successful outcome. The subject alluded to the importance of the

professional ability of people within the organization. There was also a concern about the future retirement of many PEO IWS employees and a need to maintain a continuous recruitment and development program within the organization to alleviate any loss in organizational capability from retirements.

Subject C added an important topic, customer satisfaction. His comments mostly concerned Fleet users of IWS 1.0's ultimate product, integrated combat systems. Customer satisfaction is recognized in all the previously mentioned literature as the key to survivability and growth in private sector organizations (Lynch and Cross 1995, Kaplan and Norton 1996, Simons 2000). The fact that subject C mentioned it recognized that it is important to the perceived success of IWS 1.0, as well. The fact that it was not mentioned specifically by subjects A or B does not mean that it is insignificant, only that it was not specifically mentioned.

(2) Processes. Significant processes brought out by the interview subjects included: communication, teamwork, weapon system design, contract design, contractor performance, and financial management. All recognized the importance of human capital, as well, but subject A gave it much more emphasis and included it not only as an input, but also within processes. Additionally, subjects B and C gave more emphasis to program planning and test and evaluation's (T&E) impact on ultimate outcomes of the organization

Communication is a key process that ultimately impacts all of IWS 1.0's outcomes. As interview subject C put it, it is a basic requirement that underlies all planning and execution within the organization. It includes communication within IWS 1.0, between IWS 1.0 and the rest of PEO IWS, and communication with all stakeholders outside PEO IWS.

Teamwork is closely linked with communication. It concerns internal teamwork within the separate facets of IWS 1.0, external teamwork within the rest of PEO IWS, and external teamwork with outside stakeholders. Teamwork also encompasses cooperation between separate private contractors which can be problematic because of their concerns about proprietary knowledge and maintaining competitive advantage. IWS 1.0 is the lead major program for

integrating the separate parts within PEO IWS by virtue of its mission to provide integrated combat systems to the fleet. By the nature of its work it must link the efforts of the other major programs within PEO IWS into a useful, total system for the warfighter. Integration of separate processes is at the forefront of military acquisition as noted by the emphasis on integrated product and process development (IPPD) in the Defense Acquisition Handbook.. IPPD emphasizes a multidisciplinary approach to problem solving and meeting customer and stakeholder needs.

Human capital development is an important aspect of organizational growth which has impacts throughout IWS 1.0's processes and outcomes. Not only does it impact the obvious capability of employees, but also feeds back to recruitment and retention. Current and future employees are likely to be motivated to work for an organization that allows them to improve their abilities and skill sets, regardless of the organization's motive in offering that opportunity.

Financial management recognizes that IWS 1.0 needs to intelligently manage its funding to deliver on its mission; sustainable funding is a key enabler of success. The negative consequences from poor financial management are cost overruns, schedule slippage, and rescission of funds by higher authority.

Contract design implies that the type of contract is important to contractor performance and T&E success. Subject A emphasized the need to incentivize the provider of service to meet cost, schedule and technical/performance milestones, as well as to be integrated with other contractors. The first three of those topics are already well incorporated within the acquisition communities contracting process. They are largely driven by technological maturity and by a determination of which party to the contract will bear the risks of overruns and performance failure. Regarding degree of integration, subject A emphasized that contractors could be financially motivated to interact well with other defense contractors working on a program to ensure the program met all of its goals. Specifically, at least part of any incentive bonus

would be paid only if all involved contractors met their goals. Thus, contractors would be encouraged to help one another and work together in a truly integrated program.

Weapon system design is influenced by the degree of teamwork, communication, skill of the personnel involved, and specificity of the stated requirements. As stated earlier, the IPPD process is significant and emphasizes knowledgeable personnel from multiple disciplines working together in an open manner to develop the best design within stated parameters. Subjects B and C included it within the more encompassing heading of program planning.

Contractor performance, according to interview subjects, is not fully within the major program manager's direct control, but is certainly within his or her influence. In a large sense, one of the primary responsibilities of acquisition organizations in the military is to influence contractor performance. Much of that influence is brought about by the previously mentioned processes: communication, teamwork, specificity of the contract, and a good system design.

Subjects B and C indicated that program planning plays a key role in the ultimate outcomes of the organization. That planning included, but was not limited to, acquisition strategy, maintenance strategy, including an integrated logistics support plan, a development strategy, and system design. Program planning has a significant subsequent impact on contract design which further influences contractor performance and ultimately organizational outcomes.

Test and evaluation can have a major impact on ultimate technical/performance, cost and schedule. The subjects indicated that the best way to ensure success was through robust modeling and simulation with sequentially increasing levels of fidelity to ensure the system is ready to perform before field tests are attempted. Making sure that preliminary testing is adequate saves money and time in the long run by not having to repeat more expensive operational and live fire tests because of system failure.

Risk management was depicted by subjects B and C with double-headed arrows between cost, schedule, and technical/performance. Risk can be defined as the potential inability to achieve overall program objectives within defined cost, schedule, and technical constraints (Naval Postgraduate School 2004) If there is no slack in either budget or schedule, and a program is under-performing technically, the possible outcomes that might achieve technical goals are an increase in cost or a delay in schedule. Risk is continually assessed by the program manager to determine status of the program and forecast probability of future success.

(3) Inputs. While all IWS 1.0 subjects recognized human capital as a basic input for their processes, subjects B and C recognized that the degree of technological maturity, the specificity of the system requirements, and the initial funding for any program were all important ingredients to ultimate success.

It can generally be said that any organization will function better if managed and operated by highly qualified and trained personnel as opposed to lesser skilled manpower. IWS 1.0 does not have significant levels of facilities and infrastructure; all the subjects recognized that the primary capital for IWS 1.0 resides in its people. Hiring, motivating, and retaining their human capital will be critical to the long-term success of the organization.

Mature and specific weapon system requirements are brought about by thorough, integrated analysis and they tend to eliminate ambiguity for the manufacturer. Mature technology removes risk associated with developing unproven or experimental technology.

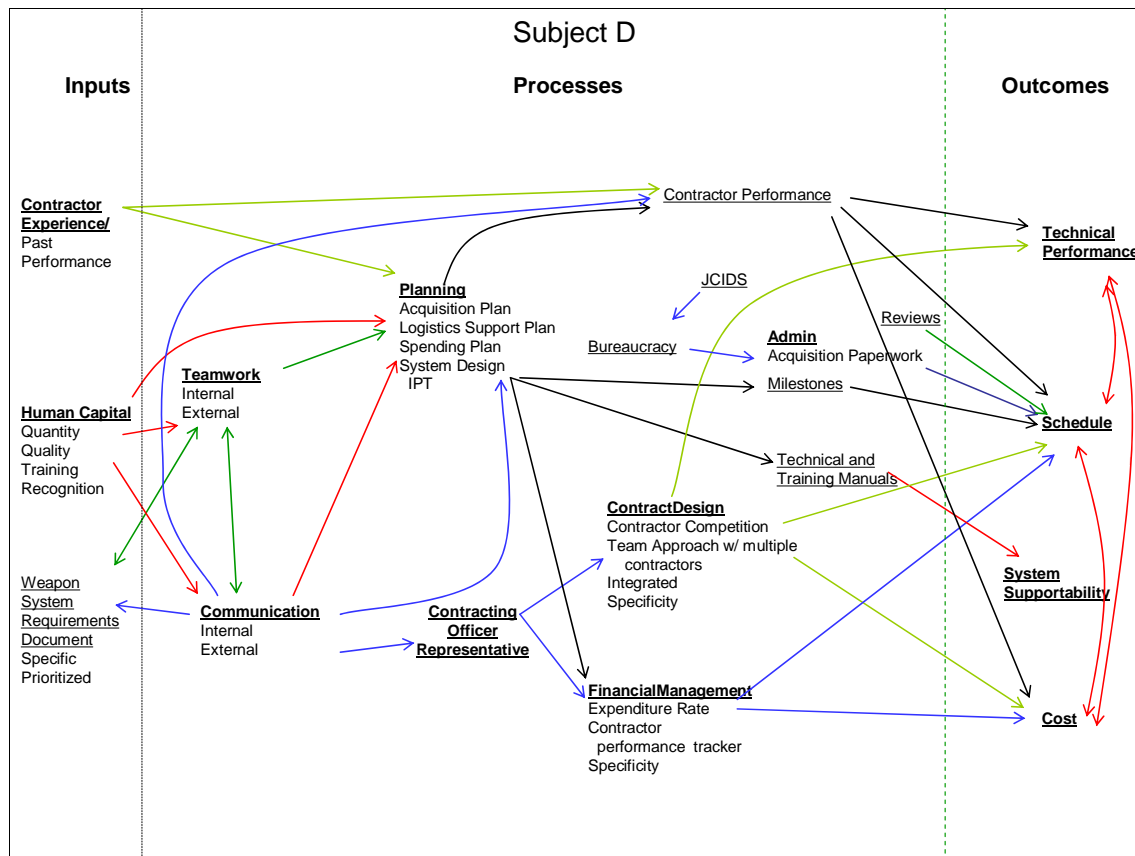


Figure 8. Causal Performance Map – IWS 2.0 Subject D

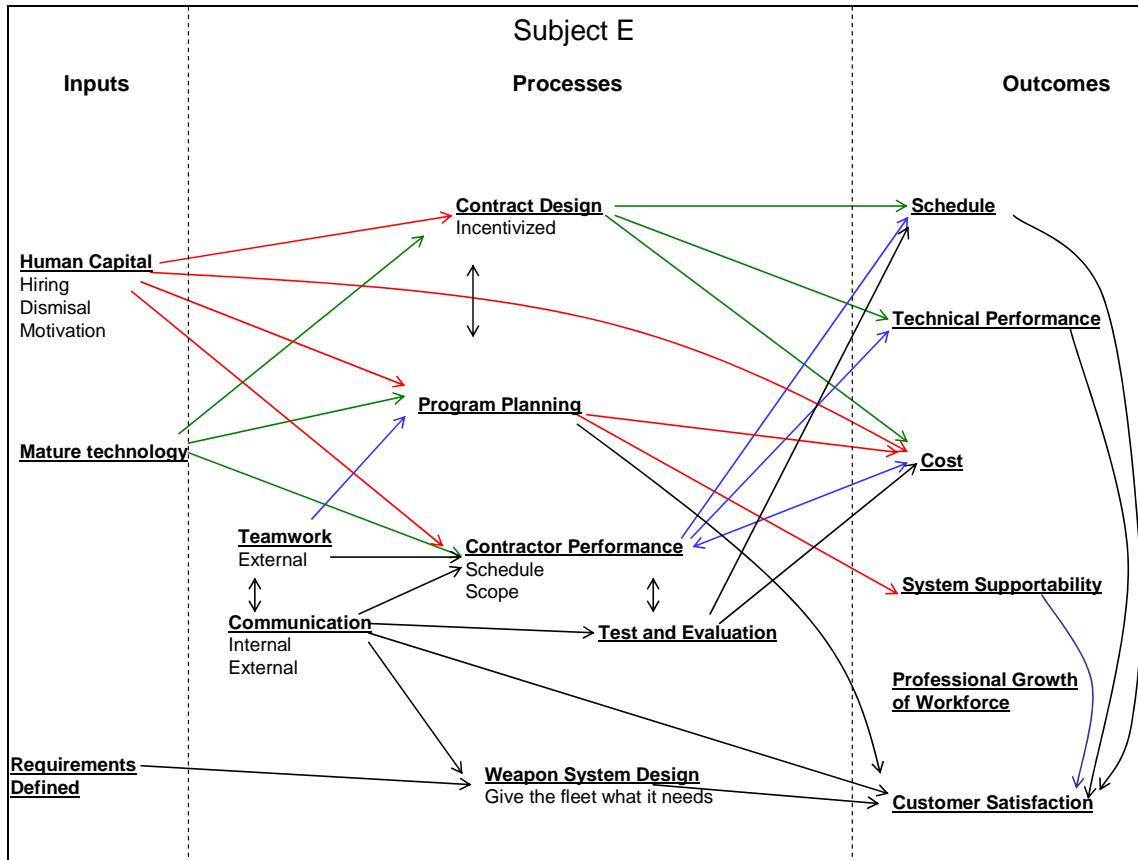


Figure 9. Causal Performance Map – IWS 2.0 Subject E

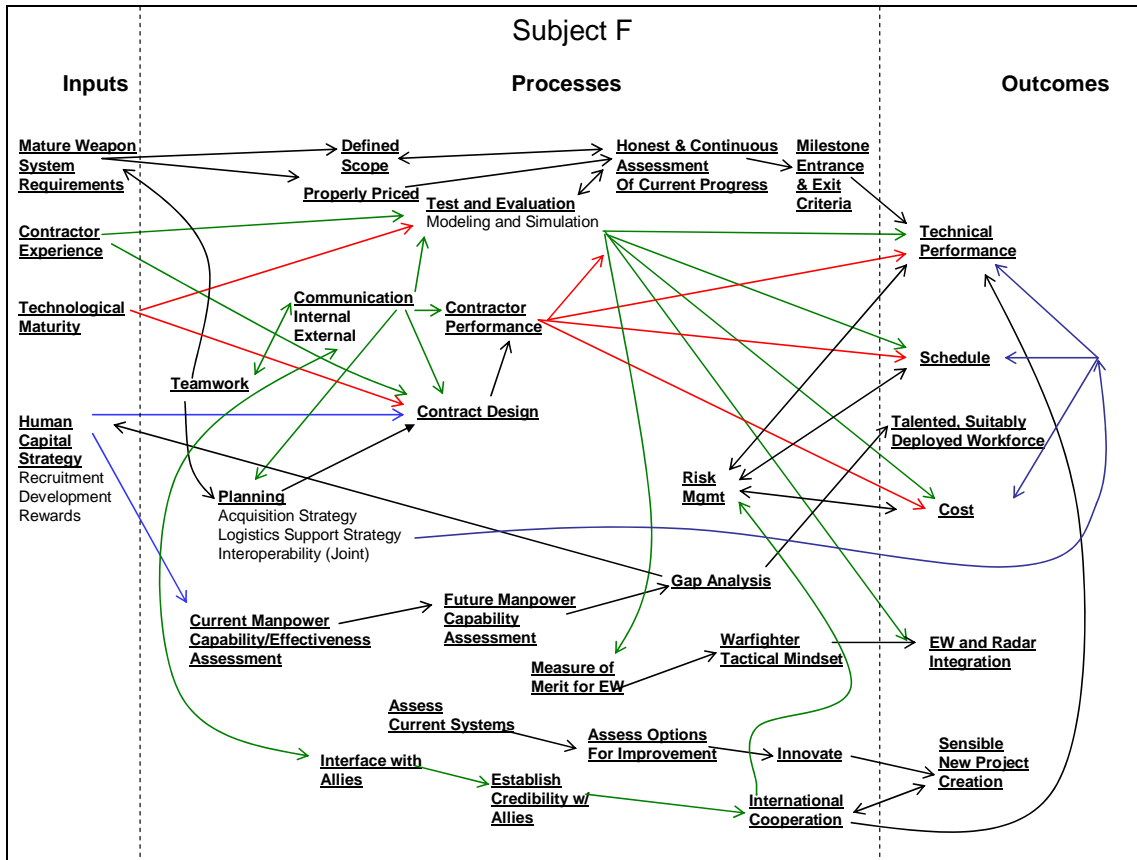


Figure 10. Causal Performance Map – IWS 2.0 Subject F

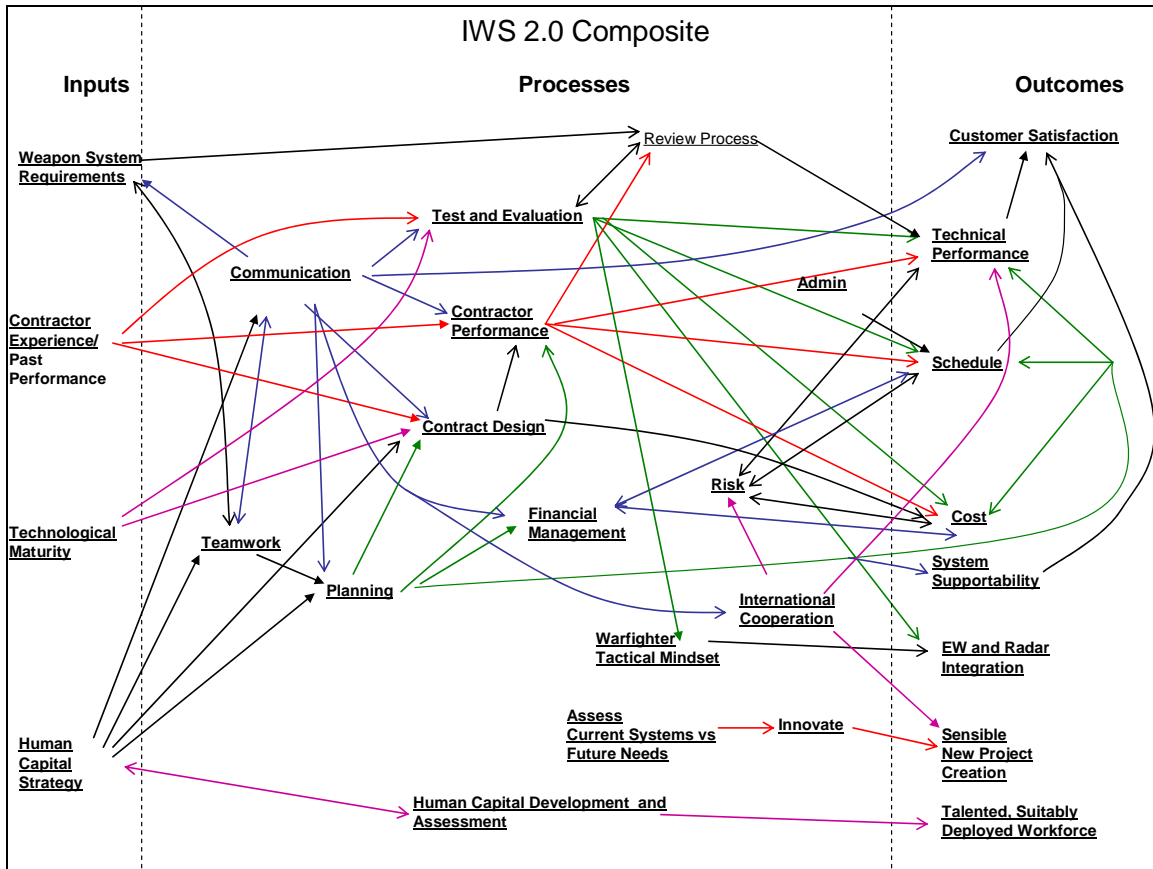


Figure 11. Causal Performance Map – IWS 2.0 Composite

b. IWS 2.0

Figures 8 through 11 were derived from the interviews within IWS 2.0, with Figure 11 being a composite map.

(1) Outcomes. As in IWS 1.0 technical/performance, schedule and cost were all identified as common outcomes. Subjects D and E also separated out supportability as a key outcome. Subjects E and F identified the talent, growth and optimal deployment of the IWS 2.0 workforce. Subject E was very focused on customer satisfaction, as well.

Subject F brought out the importance of electronic warfare (EW) and radar operating in unison as an integrated system. The thinking is that if EW systems can be well integrated into an air defense combat systems solution for the warfighter, the total system should have equal or greater combat

effectiveness at a lower total cost. Much of the hypothetical savings would come from a need to procure and expend fewer surface-to-air missiles.

Subject F also identified the importance of new project creation, where it made sense to the Navy as a whole. Because of their work with the Fleet and industry, IWS 2.0 personnel are exposed to both the needs of Navy operators and emerging technologies within industry. When they can marry the two efficiently and effectively through a new project it can be the best desired outcome for all, including tax payers.

(2) Processes. Commonly recognized factors by all three IWS 2.0 subjects were communications, teamwork, contract design, program planning, T&E, and contractor performance. Subject D identified financial management, thorough technical and program reviews and JCIDS requirements as additional determinants of organizational outcomes. Subject F acknowledged the importance of regular and honest assessment, very similar to the review process mentioned by subject D. Subject F also highlighted the risk management tradeoffs between technical/performance, cost and schedule, as well as the risk mitigation that can be derived from international cooperation. Lastly, subject F highlighted the process of comparing current system capability against available options for improvements to arrive at a more capable and/or cost effective weapon system solution. The IWS 2.0 subjects shared many of the same processes with their IWS 1.0 counterparts, and to avoid redundancy, this commentary will be limited to any differences from what was discussed for IWS 1.0.

Teamwork took on a less prominent role in the IWS 2.0 organization largely because the weapon systems that they work with do not combine inputs from other major programs within PEO IWS to the same extent that they do in IWS 1.0. That is not to say that degree of integration was unimportant, but it was not as significant as mentioned for IWS 1.0.

Contract design was an important aspect of IWS 2.0 processes and an additional factor was mentioned, the need not only for

specificity, but for the elements of the contract to be measurable. In order to hold parties to the contract accountable, and help determine contract awards, more measurable specific attributes are better.

Risk management and its importance to organizational outcomes was emphasized by subject F. Part of honestly assessing T&E progress and current system standing is comparison to the required scope covered in the requirements document. If progress is not adequate, either due to cost, performance, or schedule considerations, trade-offs may be made to keep the product either on time, on budget or aimed at accomplishing technical/performance targets.

The achievement of EW and radar integration would be influenced by acceptance of an EW system's ability to detect and deceive perceived threats to the ships employing the system. That acceptance would hinge greatly on the credibility of test results, to the extent that the ultimate user could trust and have confidence in them.

International cooperation in weapon system design allows IWS 2.0 to leverage mature technologies and experience from other nations to create better or less risky solutions to solve fleet problems. That cooperation can only take place in an environment of trust where ongoing dialogue exists. The benefits of this interaction come from the different perspectives that different cultures might bring to the same problem. New methods of solving perplexing problems have been gained in the past from altering the problem solver's paradigm.

New project creation is influenced by the aforementioned international cooperation, but also by keeping a keen eye on emerging technologies and assessing them against current systems. Existing systems can become obsolete when the technology they employ is no longer supported by industry. In that case, it would help the Fleet by ultimately improving effectiveness and system reliability for IWS 2.0 to nominate new technology solutions to the resource sponsor.

(3) Inputs. All three subjects agreed that human capital and mature system requirements were essential inputs that ultimately led to IWS 2.0's organizational outcomes. Also, subjects D and F included contractor experience and past performance while subjects E and F mentioned technological maturity of the system as influential inputs.

Contractor experience and past performance recognize that knowledge of the military acquisition process matters. Contractors that have worked in the field previously should be able to better gauge what will be required to successfully produce for the military again. Thus, their contract bids should be more accurate. Regarding past performance, it could be a good indicator of future performance.

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IV. ANALYSIS AND RECOMMENDATIONS

The causal performance maps developed for IWS 1.0 and 2.0 provide a clear window into the operations of these two major programs and illuminate variables that help them achieve their desired outcomes. Based on interview subject input and analysis of the maps, CPVs were chosen that capture the critical variables in achieving success. Those CPVs should answer the question, “Are we doing the right things?” CPVs were analyzed to determine if they should have an input, process or output metric based on the criteria articulated in Chapter II. The chosen performance metrics attempt to answer the question, “Are we doing the right things well?” CPVs and metrics were then organized into a balanced scorecard framework aligned with PEO IWS and enterprise strategic goals.

One thing that was evident from the causal performance maps was that IWS 1.0 and 2.0 have many inputs, processes and outputs in common. They are similar organizations with similar aims. Table 2 displays the inputs, processes and outcomes for both IWS 1.0 and 2.0 and then identifies those that are common to both. The following analysis applies to both IWS 1.0 and 2.0 and is based on the list of common CPVs.

It was apparent that success for both IWS 1.0 and 2.0 is influenced by more than just cost, schedule and technical performance. To a great extent, these three outcomes define success for IWS 1.0 and 2.0, but they are not the only outcomes that will help IWS 1.0 and 2.0 contribute to their long-term goals. They are only lagging indicators of success. Monitoring some of the leading CPVs should provide leading indicators of success or identify problems that require a manager's preemptive action. Contained in the following analysis are potential performance metrics. It is important to reiterate that these are recommendations only. They are derived from the interviews, past research by other authors, strategic Navy documents, and the author's experience. It is rare that one person can individually determine valuable metrics for an organization,

and if a single person could, they would need to be intimately familiar with both the organization and its industry. Typically, almost universally, good metrics development requires integrated input and analysis from throughout an organization. The following suggested metrics should be viewed as recommendations for an organization-wide metrics process at PEO IWS, and as focus points for IWS 1.0 and 2.0 to consider when evaluating potential metrics for their major program areas. Also, there are more CPVs and metrics listed here than IWS 1.0 or 2.0 will likely choose to implement. The following list is drawn from the maps and intended to be a broad list that the major program managers can choose from or modify at their discretion.

It appears that to just measure outcomes would leave a rich avenue of leadership influence without any guideposts to aid in decision making. While many good managers and leaders intuitively emphasize all areas that influence strategic success, not all do. Developing metrics for all areas of the strategy will ensure all parts of the strategy get management attention (Kaplan and Norton 1996). Additionally, it will communicate to all levels of IWS 1.0 and 2.0 what is viewed as important to the major program managers. Providing a mix of leading and lagging indicators will provide managers with an ability to take action before outcomes are decided as well as measure those ultimate outcomes.

The scorecard for IWS 1.0 and 2.0 displayed later in this chapter has been organized along the format put forth by Kaplan and Norton (1996). The four classic perspectives of learning and growth, internal business processes, customer, and financial have been replaced with the strategic perspectives identified by PEO IWS. The Kaplan and Norton perspectives are listed in parenthesis where they match with the more specific PEO IWS perspectives.

IWS 1.0	IWS 2.0	Common
<u>Inputs</u> Technology Maturity Human Capital Weapon System Requirements	<u>Inputs</u> Technology Maturity Human Capital Strategy Weapon System Requirements Contractor Experience	<u>Inputs</u> Technology Maturity Human Capital Weapon System Requirements
<u>Processes</u> Teamwork Program Planning Contract Design Test and Eval Contractor Performance Communication Human Capital Development Financial Management FRP Surge Status Ship Construction Schedule Risk	<u>Processes</u> Teamwork Planning Contract Design Test and Eval Contractor Performance Communication Human Capital Development and Assessment Financial Management Review Process Administration Risk International Cooperation Warfighter Tactical Mindset Assessment of Current System vs. Future Needs Innovation	<u>Processes</u> Teamwork Planning Contract Design Test and Eval Contractor Performance Communication Human Capital Development Financial Management Risk
<u>Outcomes</u> Customer Satisfaction Schedule Cost Technical/Performance Capability of IWS Team Secure Funding	<u>Outcomes</u> Customer Satisfaction Schedule Cost Technical/Performance Talented Suitably Deployed Workforce Supportability EW and Radar Integration New Project Creation	<u>Outcomes</u> Customer Satisfaction Schedule Cost Technical/Performance Capability of IWS Team (Talented Workforce)

Table 2. IWS 1.0 and 2.0 Common Critical Performance Variables

The scorecard organizes the metrics under perspectives which show their strategic alignment. The four perspectives in IWS 1.0 and 2.0's scorecard are aligned with NAVSEA and corporate Navy strategic objectives as depicted in Figure 3 and 4. By then aligning organizational strategic objectives, CPVs, and metrics under those four perspectives, the users are able to see how their efforts, as measured through the metrics, can contribute to not only IWS 1.0 and 2.0 success, but also PEO IWS, NAVSEA, and Navy strategic success. That ability to tie disparate parts of the organization together, focus their energy on strategic goals, and provide relevance to employee efforts is one of the main benefits of a balanced scorecard and performance measurement system.

As stated earlier, the list of metrics is longer than would likely be chosen to be monitored by IWS 1.0 and 2.0, but it is intended to serve as a list of possible metrics to choose from or modify. Thus, the scorecard is spread across three figures in order to present all the potential metrics. Any italicized CPVs and metrics were those that were identified only by IWS 2.0 subjects. The boldfaced metrics are those that appear to be currently collected and utilized at IWS 1.0 and 2.0. Just because a metric is not boldfaced does not mean the data are not being accumulated, it merely means that they may not formally be reported to the major program managers. The analysis as to what was currently being utilized by IWS 1.0 and 2.0 was somewhat subjective because much of what is currently monitored is done so informally.

A. CRITICAL PERFORMANCE VARIABLES AND USEFUL METRICS

The CPVs are inextricably linked together in a web of causal links, particularly human capital, communication and teamwork. The causal maps bring this out by the web of lines between CPVs. The spider web of links can be initially intimidating to the user, but persistence in evaluating the maps can bring insight into factors that impact IWS 1.0 and 2.0. The following analysis is followed by a potential balanced scorecard for IWS 1.0 and 2.0 that lists possible

metrics for both major programs. The following CPVs are arranged by balanced scorecard perspectives with IWS 2.0 specific CPVs discussed within the Programmatic perspective.

1. Personnel

a. Human Capital

Human capital is critically important to the health and success of both IWS 1.0 and 2.0. “People are our greatest asset,” is a commonly used adage in the Navy. In fact, at IWS 1.0, the following statement is posted on one of the office doors, “It’s the PEOPLE, it’s the PEOPLE, it’s the PEOPLE.” That sentiment is never truer than in a knowledge-based organization like PEO IWS. The keys to organizational success are contained within the people themselves in the form of their expertise and experience. This was very apparent in the maps for both IWS 1.0 and 2.0. Human capital ultimately affects all other outcomes.

Any leadership pipeline has to begin with attracting employees, some of whom will become the future leadership within the organization. Those employees need to be of sufficient quality that they can excel at their current jobs and learn new skills to move into areas of greater responsibility. PEO IWS has a senior workforce, with over half of its 278 civilian employees at the GS-14 grade or higher. It was apparent from interviewees’ comments that many of these workers will be eligible for retirement during the coming decade. This is a long-term problem with a long-term solution and PEO IWS must address this potential future human capital loss now in order to minimize loss in capability as the current workforce retires. Largely due to budget pressures on manpower accounts, hiring is controlled at the NAVSEA level and is outside the major program manager’s direct control. However, the major program manager must remain aware of the current manning situation in order to apply whatever pressure available to the chain of command to hire appropriate personnel. It is unclear if the new National Security Personnel System will allow managers more direct control over hiring personnel. One indicator of the health of the leadership

pipeline might be the number of interns working within IWS 1.0 and 2.0. A large number of interns indicate that there are fresh, talented newcomers to replace retiring employees.

One area of the human capital equation that is under the direct control of major program managers is development and motivation of existing personnel. According to interviewees, skill and experience development through cross-training, broad exposure to new challenges and different varieties of program management, and attendance at training courses and professional seminars are long-term enablers of organizational success. Although time consuming, constant improvement of workforce skills is necessary to leverage new technologies and to enable continuous improvement. Mentoring by senior personnel is another aspect of development that can have good results (Fisher 2005). A good monitor for these activities is the development and review of individual leadership development plans (ILDLP). These are contracts between leaders and their subordinates that identify professional goals of the subordinates and needs of the organization. They then focus on the skills that the subordinates need to attain or to improve their own standing and meet the needs of the organization. ILDPs provide a methodology for improving the skill level of the employees, and a baseline for the manager to monitor the professional development of the subordinates. ILDPs are used throughout IWS 1.0 and 2.0, but subsequent monitoring for achievement of goals has been individual manager dependent in the past.

Retention of PEO IWS's critical human capital is important to future success. After the investment of time, funds, and energy in training and developing personnel, it is essential that these valuable employees be retained. Retention is enhanced by many things including the ability of employees to improve their skills, by monetary and non-monetary rewards, and promotions. A good leading indicator of retention can be employee satisfaction. Happy employees tend to stay on the job longer, and tend to produce better work results (Heskett, Sasser, and Schlesinger 1997). An in-depth analysis of contributors to

employee satisfaction, through interviews or questionnaire, can contribute significantly to the managers understanding of the drivers behind retention.

As demonstrated in recent efforts to focus the Navy budget on the recapitalization of ships and aircraft, reductions in manpower can be viewed as a means to free funds for higher priority needs. Recent reductions in contractor support and hiring restrictions within NAVSEA organizations are good examples. While that may be the reality of the budget situation, accurate human capital metrics are needed to measure the impacts of those decisions. Much like a building that requires consistent investment in maintenance to sustain itself over time, human capital needs consistent investment of time, money, and energy to continuously improve and meet organizational strategic goals.

In a cost cutting environment, improving individual employee productivity is essential to sustaining or improving organizational effectiveness while maintaining or decreasing manpower costs. There is a finite limit to which employee costs can be cut. Improved employee commitment from a demonstration by IWS 1.0 and 2.0 to employee professional growth could have a positive impact of productivity.

Human capital as an outcome aims to answer an important question, “Do we have the right number of properly skilled employees in the right jobs to succeed for the long-term?” If the answer to that question is yes, then much of the other strategic goals of IWS 1.0 and 2.0 should be attainable. A large part of ensuring people are in place for the long-term will be gauging their commitment to the organization. It is not enough to have the right people now, there needs to be some confidence that they will be there in the future. Commitment of employees to the organization, along with their satisfaction and motivation will be key drivers of future retention (Fitz-enz 2000). Additionally, a plan for what people will be needed in the long-term will be required.

2. Programmatics

It was apparent from the interviews that three primary variables have been the focus of performance metrics at PEO IWS and throughout the acquisition

community: cost, schedule and technical/performance. All but one of the interview subjects named these three variables as the most important factors to measure. The programmatic perspective contains two of these variables: cost and schedule.

One useful method for analyzing a program's progress towards completion is the Earned Value Management System (EVMS). EVMS is a management tool that integrates cost, schedule and technical performance into one tracking system, and should provide excellent indicators of progress if reviewed regularly. An EVMS tracking system is expensive for a contractor to set-up, and it is only required on cost or incentive contracts, subcontracts, intra-government work agreements, and other agreements valued at or greater than 20 million in then-year dollars.

Earned value is the actual physical work completed on a project. Cost performance index (CPI) compares the budgeted cost of work performed (BCWP) to the actual cost of work performed (ACWP).

$$\text{Cost Performance Index} = \text{BCWP} / \text{ACWP}$$

Cost variance (CV) is determined by subtracting ACWP from BCWP.

$$\text{Cost Variance} = \text{BCWP} - \text{ACWP}$$

Schedule performance index (SPI) compares the BCWP to budgeted cost for work scheduled (BCWS).

$$\text{Schedule Performance Index} = \text{BCWP} / \text{BCWS}$$

Schedule variance (SV) is determined by subtracting BCWS from BCWP.

$$\text{Schedule Variance} = \text{BCWP} - \text{BCWS}$$

Together these indices and variances indicate actual cost and schedule relative to plan. With variances, a positive value is favorable. With the indices, a value greater than one is favorable.

The program manager variance at completion (PM VAC) and the contractor variance at completion (CONTR VAC) are the estimated total cost at contract completion minus total budgeted cost at contract completion.

Thresholds are set above and below an established baseline to act as tripwires to cue leadership action. They indicate to anyone who looks at the data whether the program is or is not performing to plan, whether unfavorable or favorable, and that analysis is required to determine the cause.

Even when EVMS is not required, the basic logic should still be followed. An original baseline should be derived from which cost and schedule deviations can be observed and acted upon, if required.

a. Cost

Cost of a weapon system is an outcome of contractor performance and program management. It is closely tied together with technical/performance and schedule. Trade-offs between cost, schedule and performance lead to reductions or increases in their nominal values. Indicators of cost performance are primarily delivered through EVMS and close communication with the contractor and Contracting Officer's Representative (COR). The use of EVMS is growing in the acquisition community with its use required at lower total contract values than previously mandated.

b. Schedule

Schedule is influenced by many variables and tracking any of those should be indicative of future schedule slippage. Funding, cost, technical performance, employee competency, contractor performance, contract design, and T&E can all influence schedules. Also, changes in the external factors beyond the program manager's control can have a large impact such as ship delivery schedule and availability of ships due to operational "surge" requirements.

c. Test and Evaluation

The T&E process is a good indicator of program success. Because of the iterative process of T&E, from less to more demanding testing, each separate phase provides an opportunity to evaluate the current and potential

success of the program. The Defense Acquisition Guidebook outlines Development, Test, and Evaluation best practices and provides some ideas for potential leading metrics for T&E and program success. These metrics are depicted in the proposed balanced scorecard.

d. Risk Management

Managing risk is one of the essential tasks of program management. A risk management strategy is determined, usually by an integrated team, and published in a Risk Management Plan. A level of risk can be assigned to any event or outcome, but it is of primary concern in program management at PEO IWS in terms of cost, schedule, performance, and funding risk.

One common method to determine risk is by a risk rating matrix. A generic risk rating matrix is depicted in Figure 12. Risk events are decomposed into likelihood and consequences. Likelihood is stated as an adjective describing the probability of occurrence, either remote, unlikely, likely, highly likely, or near certainty. Consequences are described by potential program impact if a risk event were to occur, either minimal/none, slight, moderate, significant, or unacceptable. A risk rating is then assigned by plotting the risk likelihood on the vertical axis of a chart and risk consequences on the horizontal axis. The intersection of the likelihood and consequences in the chart are the risk rating. In Figure 12, event 1 is medium risk and event 2 is low risk.

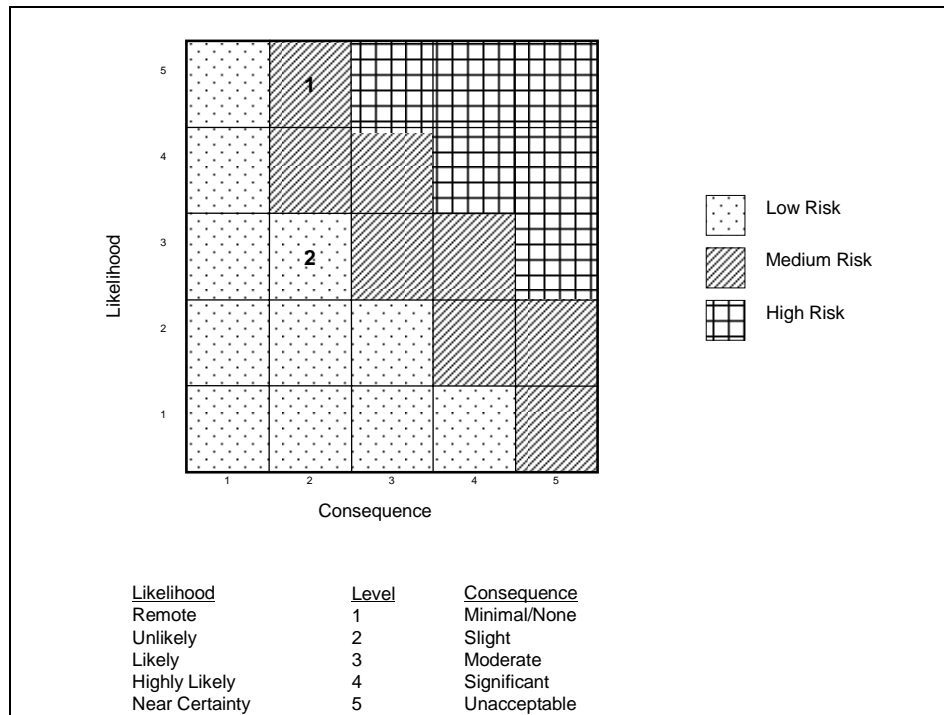


Figure 12. Risk Rating Matrix (From: Naval Postgraduate School 2005)

At a minimum, a subjective risk assessment should be executed by the program manager based on experience and an assessment of what is known about program variables and the external program environment. Objectivity would be preferred over subjectivity, in most cases. One method of making a more objective determination is by assigning specific definitions to the adjective ratings for likelihood and consequences that are then used universally throughout the program. The benefits might include better trend analysis over time and a reduction in bias of the subjective risk rating. The risk rating can be used by the major program manager to track risk in his or her many programs.

Risk must be tracked systematically during the acquisition process (Naval Postgraduate School 2004). Key events can be utilized to measure risk. T&E events serve as good points to monitor and reassess risk. Performance, cost, and schedule progress can be compared against a pre-established baseline to evaluate probability of attaining ultimate program goals within predefined constraints.

The Earned Value Management provides an excellent risk indicator. At any given point in system development, cost and schedule execution can be compared to the baseline to determine current status, and future status can be forecast. Risk can be determined from current progress relative to baseline.

e. *Communication*

Communication can be the glue that holds an organization together and keeps its different parts moving forward together. Interview subjects emphasized the importance of communication to their staying abreast of the health of their programs and in building relationships which were essential to good program management. From the maps it is evident that communication effectiveness has impacts throughout the other processes and outcomes. As stated earlier, neither IWS 1.0 nor 2.0 produces the systems that they are responsible for providing to the Fleet. They add value to the Navy by expertly managing the acquisition and support of those systems. To provide that value they must coordinate their activities both internally and externally and gather and disperse information to all stakeholders.

Effective communication can be the key to organizational success. In one study, researchers concluded that the benefits obtained from quality internal communications included:

- improved productivity,
- reduced absenteeism,
- higher quality of services and products,
- increased levels of innovation,
- fewer strikes, and
- reduced costs (Clampitt and Downs 1993).

Another researcher commented, "The manager does not leave meetings or hang up the telephone in order to get back to work. In large part, communication is his or her work (Mintzberg 1989)."

It can be very difficult to monitor the inputs to and process of communication. One measure of an input to communication might be the

robustness and quality of the information exchange network, including databases, email and telephones. One of the characteristics of a good performance metric is that it be within the ability of the manager to influence. With the advent of the Navy's enterprise-wide intranet service, the flexibility of the major program manager to influence communications hardware and software has been curtailed, thus this may not be the most useful metric.

A better focus for a measure might be the outcomes of the communication process. Many of the outcomes are measurable during the many reviews that an acquisition program must go through during its development and ultimate fielding. These incremental reviews give indications as to the progress of a program. It is evident from the causal performance maps that communication can cause adverse effects to that progress. One way to prepare for reviews might be for the program manager to ask him or herself, "What problems could poor communication cause on this program," and then look for those problems (Hargie and Tourish 2000). If the program is not making desired progress then communications might be one of the contributing factors. The program manager must make a detailed analysis of the effectiveness of communication at that time, if not before. A leading indicator might be frequency of interactions with stakeholders in a process.

One periodic and effective method of measuring communications effectiveness is via a communications audit. The audit can measure or identify quality of information communicated, quality of communication relationships, organizational communication networks, and bottlenecks in existing networks. The audit can give a clearer picture about what is happening in an organization compared to what leadership might think is happening (Hurst 1991). This audit is best done via questionnaires or interviews. The least time intensive, most anonymous, and best method for trend analysis and benchmark comparisons tends to be with questionnaires (Hargie and Tourish 2000). The audit can help identify if communications are flowing fluidly inside and outside the organization and locate points that are acting to impede communications flow. One outcome of this process might be to identify communications training that can help the

organization communicate more effectively. Other benefits might be to recognize an inefficient organizational structure or to identify needed communications infrastructure improvements.

Another more subjective method could be to emphasize the importance of communication to employees and subsequent review of their performance in that area during annual individual performance reviews. What gets emphasized daily and during reviews is hopefully where employees will maximize their efforts. Additionally, some amount of monetary awards can be dedicated to rewarding employees who display effective communication as measured in communication audits, or other methods.

Communication is the basis for relationships and international cooperation. The amount of cooperative weapon systems development with allies could be an indicator of communication's effectiveness, assuming an ongoing effort for international engagement exists.

f. Teamwork

Teamwork is especially important for IWS 1.0 because of its focus on integrated combat systems. It is very difficult to build an integrated system without sound teamwork. IWS 1.0 integrates the work of multiple major programs into a fully combat-capable system. The AEGIS radar is a good example. IWS 1.0 handles the combat system while IWS 2.0 handles the radar hardware portion of the system. Without close coordination and teamwork, the final combat system will not function as well as envisioned, if at all. The composite maps for both IWS 1.0 and 2.0 show the ultimate affects of teamwork on the outcomes of the organizations. For IWS 1.0 it influences all but development of human capital, and for IWS 2.0 it has equally significant impacts.

Like communication, teamwork can be difficult to objectively and quantifiably measure at the input or process stage. One useful point of measurement might be the degree of stakeholder participation in regular program meetings. Those stakeholders would include but are not limited to other program managers that are involved in development of a particular combat system,

weapon system contractors, resource sponsors, T&E personnel, and Fleet representatives. Teamwork is the key to the IPPD process. Strong teamwork and a multi-disciplinary approach, started at the beginning of a program's conception and development, should improve chances of success and decrease total life cycle cost of a weapon system (Department of Defense 2005a).

How well integrated a program is should be evident from the previously mentioned communication audits. It is difficult to be integrated without effective and regular communication. If the communication audit indicated that a key member of a system development team was working in isolation that might be a good indicator of future problems and an area for management action.

Planning reviews and preparations for them are good points for manager evaluation of the degree of teamwork on a program. The manager should be able to gauge the degree of internal and external coordination by the review. One of the key IPPD tenets is multidisciplinary teamwork through Integrated Product Teams (Department of Defense 2005a). A determination of how well the IPPD principles are being followed could be one of the take-aways from a review.

Sharing of award incentives could motivate teamwork amongst both PEO IWS employees and contractors. In order for anyone to collect award fees or personal reward incentives, the entire team must meet its goals. This could hopefully foster teamwork since all would have an incentive to help each other succeed.

T&E can provide a lagging indicator of how well integrated a program is. If the separate parts that make up a system have not been designed and assembled in a coordinated fashion, with good teamwork between all concerned, then the results of T&E will most likely be below expectations.

g. Contractor Performance

By the nature of the business, contractor performance is critical to the success of any acquisition program. From the causal maps it is relatively easy to see that contractor performance impacts technical/performance, cost and

schedule. Regardless of the expertise of the program manager, if the contractor does not adequately perform, despite the program manager's best efforts, the program will not succeed. That said, the best way for the program manager to specifically monitor contractor performance is through frequent and precise communication, and a close relationship with the COR and the contractor team. Frequent and honest assessments are essential, as is an accurate EVMS appraisal at regular intervals.

Contractor performance must be evaluated for its impact on system cost, schedule, and technical/performance. EVMS allows that evaluation. EVMS data is frequently at least 30 days out of date by the time it reaches a program manager. Close coordination with the contractor and the COR allows the program manager to get up to date information when required.

When used properly, EVM allows government and contractor program managers visibility into technical, cost and schedule planning, performance and progress on their contracts. This visibility provides not only insight to contract performance, but provides data points to statistically estimate completion costs (Department of Defense 2005b).

EVMS has been a part of program management for 37 years and is well understood in the acquisition community. The recent reduction in threshold for implementation of EVMS from certain contracts valued at greater than 73 million dollars to those valued at greater than 20 million dollars appears to be indicative of its perceived value as a tracking tool for program health.

h. Contract Design

Contract design can have a large impact on contractor performance, cost and schedule. If insufficient risk is borne by the contractor, there may be a reduced incentive to deliver on time and on budget. Specificity of terms within the contract seems to be of significant importance. Additionally, team incentives might prove useful in generating teamwork among contractors.

i. Planning

The old saying goes, "Prior planning prevents poor performance." That is as true in acquisition as in other endeavors. An integrated and

comprehensive planning process can lead to excellent results. Time invested at the beginning of the process should pay dividends at the end by minimizing rework. The review and decision point processes within the acquisition framework provide adequate opportunities to gauge the robustness of planning and strategy development. A lagging indicator might be the historic accuracy of planned cost and schedule performance for IWS 1.0 and 2.0. Continuously improving accuracy might be indicative of accurate planning and forecasting.

j. Contractor Past Performance

Contractor past performance can be an indicator of future performance and can act as a leading indicator of success. It can be evaluated using the Contractor Performance Assessment Reporting System (CPARS). A possible metric might relate the total number of contracts within a major program area to number of contracts with contractors that have received favorable average past performance ratings.

k. Technology Maturity

The maturity of required technology can be accurately gauged via technology readiness assessments. It is the primary initial indicator of risk. If the system requires yet to be developed technology, that would be indicative of high risk. That risk will ultimately help determine contract design and impact acquisition strategy.

l. IWS 2.0 Specific CPVs

(1) International Cooperation. International cooperation was deemed important in IWS 2.0 by subject F. It is enhanced through strong relationships and regular communication. It acts to mitigate risk and stimulate new program creation by allowing access to technology that might be superior to that available from U.S. defense contractors. Even if not superior, the different perspectives regarding system design and development found amongst our allies might offer innovative solutions.

(2) EW and Radar Integration. EW and radar integration is a goal for IWS 2.0 focused on getting more combat effectiveness by maximizing the benefits that both EW and radar can bring to the warfighter. From the

interviews it was evident that the effort needs to focus on getting the warfighter to have confidence in the EW system's ability to detect and deceive a threat. That goal can be achieved through T&E and Fleet exercises and subsequent active communication of those results to the Fleet in order to engender confidence.

(3) New Project Creation. New project creation for its own sake is not the goal that IWS 2.0 is after. The interview subjects indicated that it is only in improving Fleet readiness in a cost effective manner that new projects make sense. The need for and creation of new projects is influenced by international cooperation and innovative employee ideas. IWS 2.0 has access to knowledge concerning cutting-edge technology and allied weapon development efforts. By maintaining and enhancing ties to allies and industry, they can derive innovative ways to improve Fleet weapon systems.

3. Fleet Readiness

a. Technical/Performance

Operating as designed and meeting key performance parameters (KPP) as laid out in requirements are essential outcomes in weapons acquisition. All six interview subjects identified this along with cost and schedule as key outcomes that defined success. Performance is primarily evaluated via T&E. System performance is compared against key performance parameters and specific test criteria to evaluate system readiness to proceed to the next level of testing and ultimately on to Fleet introduction.

b. Supportability

IWS 2.0 personnel specifically identified supportability as an area of concern and a critical performance variable. It seems that financial support for training and technical manuals is one of the easier items to reduce if there are cost overruns on a program. Supportability is more than just technical manuals and also includes a good plan to keep the systems operating at full potential. IWS 1.0 interview subjects included supportability as a subset of technical/performance. The metrics in the balanced scorecard are germane to both major programs.

c. *Customer Satisfaction*

Customer satisfaction is the ultimate test of the acquisition system. If the Fleet gets the weapon systems it needs to fight and win, and is satisfied with the reliability, usability, supportability, effectiveness, and cost, then PEO IWS 1.0 and 2.0 will most likely consider their efforts a success. Communication plays a role in satisfaction. The ultimate user needs to have an expectation regarding a new system. System function will be judged against that expectation. If there is no communication between the acquisition community and the Fleet concerning a new system's use and capabilities, then there is likely to be a misguided expectation as well as lower acceptance of the new system. This expectation can also be influenced by the amount of involvement in system planning by Fleet personnel. The more involvement, the more likely that Fleet needs will be identified and incorporated, positively impacting ultimate satisfaction.

Another useful tool to measure customer satisfaction would be a customer satisfaction survey. Additionally, weapon systems instructors and field engineering activities that respond to system casualty reports (CASREPS) would be a useful and knowledgeable survey audience to get a feel for Fleet satisfaction with IWS 1.0 and 2.0 efforts.

4. *Business*

a. *Financial Management/Funding*

Money, in the form of funding, provides the grease that keeps the acquisition machine running. Sufficiency of funding and appropriate management of those funds impact cost, schedule and technical/performance. Financial management is impacted by the expertise of the personnel that are managing the funds, effectiveness of communication, teamwork, and planning. Some key metrics for financial management effectiveness are listed below.

Maintenance of funding across the FYDP is vital to program schedule and cost maintenance, as well as meeting technical/performance requirements. Program strategies and contract execution are all dependent on maintaining planned funding. The best metric to use for monitoring funding

overtime is tracking rescissions and reductions to a budget. The best leading indicator of threats to program outcomes is the difference between estimated funding required and funding currently programmed.

B. BALANCED SCORECARD

The performance metrics suggested in the Proposed Balanced Scorecards (Tables 3-5) may be currently useful for IWS 1.0 and 2.0, but they need to be flexible over time for multiple reasons. First, as the strategic environment changes, IWS 1.0 and 2.0 will need to change and adjust in order to continue to improve and succeed. The performance metrics may need to change as well, since they should be a reflection of the organizational strategy.

Second, organizations learn to maximize performance relative to metrics. That was one reason to communicate metrics throughout an organization -- to influence employee behavior. While maximizing what is measured, other parts of the strategy may be neglected, or other measurable aspects of the CPVs and outcomes may be ignored.

Third, performance metrics may cause unintended dysfunctional behavior by employees trying to maximize performance relative to the metrics. For those reasons and probably more, the performance metrics should be refined regularly to ensure they are still capturing relevant information for achieving the organizations strategic goals. The result of that review is hopefully a zero sum evolution. If any measures are added, others should be taken out, so that a sort of metrics overload does not take hold; measures should be prioritized for value toward achieving the strategy.

IWS 1.0 & 2.0 Balanced Scorecard			
Perspective	Objectives	CPVs	Potential Metrics
Personnel (Growth and Learning)	A. Optimum Staffing B. Develop a professional, competent workforce C. High quality of life for the workforce	A. Human Capital	A. Number of full time equivalent (FTE) employees A. Number and % of vacant positions by grade A. Employee satisfaction A. Employee productivity - First time pass rate of systems at reviews, milestones and T&E events / manpower cost - % of programs on schedule and budget/ total manpower costs A. Employee retention A. % of ILDP goals attained on time A. Number of professional qualifications attained A. Financial awards delivered / rewards available A. Number of promotions within the organization A. Total training costs A. Total number of vacation days/FTE A. Total number of absent days/FTE

Table 3. IWS 1.0 and 2.0 Proposed Balance Scorecard – Personnel

IWS 1.0 & 2.0 Balanced Scorecard			
Perspective	Objectives	CPVs	Potential Metrics
Programmatics (Internal-Business- Process)	A. Be the acknowledged expert and sole program authority for Navy combat systems	A. Cost B. Schedule C. Test and Evaluation D. Risk E. Communication F. Teamwork G. Contractor Performance H. Contract Design I. Planning J. Contractor Past Performance K. Technological Maturity L. <i>International Cooperation</i> M. <i>EW/radar integration</i> N. <i>New projects/innovation</i>	A.G. Cost variance and trend A.D.G. Cost performance index A.D.G. Estimated cost at completion (EAC) relative to planned budget A.G. EAC relative to contractor's best case amount B. % of interim milestones met per original schedule B. Number of schedule adjustments B. % of major milestones met per original schedule B.D.G. Schedule variance and trend B.D.G. Schedule performance index C. % T&E managers with good past performance C. % test community participation in testing strategy development C. Days slack time in the plan T&E. C. % of contractor models that are validated C. % of modeling and sim completed on-time C. Number of critical trouble reports generated for each fixed critical trouble report. C.E.F. % systems passing review and T&E on first attempt D. Objective risk rating E. Communications effectiveness (audit) E. Performance reviews E. Email network analysis E.F. % of identified stakeholder orgs invited to and attending program meetings. F. Teamwork survey F.H. % of strategies developed using IPTs F. % of total incentives tied to team performance G. EAC trend H. % of contracts that are cost-plus contracts H. % of contracts with team incentives I. Historic trend of cost and schedule over-runs relative to original plan. J. % of contractors w/ favorable past performance rating K. % of technologies that are currently producible K. % of technologies that are currently in development L. Number of joint initiatives with allies in the previous year L. Number of meetings with allies in the past year M. Confidence in EW system (survey) M. Number of joint initiatives with allies in past year N. Number of newly funded programs in the past year

Table 4. IWS 1.0 and 2.0 Proposed Balance Scorecard – Programmatics

IWS 1.0 & 2.0 Balanced Scorecard			
Perspective	Objectives	CPVs	Potential Metrics
Fleet Readiness (Customer)	A. Stay the course set while taking it to the next level	A. Technical/Performance B. System Supportability C. Customer Satisfaction	A. Test and Evaluation first try pass rate A. Exercise and live fire success rate A. % of systems meeting KPPs B. % reductions to training and tech manual budget B.C. System mission capable rate B.C. Number of CASREPS/quarter B.C. Average down time per CASREP C. Customer survey
Business (Financial)	A. Proactively manage all phases of the budget process using best commercial practices to the maximum extent possible	A. Financial Management/ Funding	A. Obligation Rate vs. Benchmarks A. Obligation Rate vs. Plan A. Expenditure Rate vs. Benchmarks A. Expenditure Rate vs. Plan A. Number of programs reduced A. Programmed budget less required budget across FYDP A. % of contracts meeting benchmarks

Table 5. IWS 1.0 and 2.0 Proposed Balance Scorecard - Fleet Readiness and Business

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V. CONCLUSIONS AND RECOMMENDATIONS

A. INTRODUCTION

There is an obvious need for performance measurement in Navy commands. It is required by statute and desirable from a leadership standpoint. This thesis has attempted to demonstrate a methodology for arriving at performance metrics, in this case for IWS 1.0 and 2.0. First, performance drivers were captured for IWS 1.0 and 2.0 via interviews with key leaders in those two major programs. Those interviews were transformed into causal performance maps which depicted the interplay of the drivers and the outcomes they influence. Performance metrics were then derived for the drivers and outcomes and arranged in a balanced scorecard format. The scorecard may be useful to the major program managers in monitoring the progress of their organizations at achieving strategic goals. Additionally, the metrics should enhance understanding of strategic direction by the rank and file of IWS 1.0 and 2.0 if they are openly discussed and analyzed.

B. BALANCED PERSPECTIVE

It was evident from the interviews and the causal performance maps that there are many diverse factors that impact strategic organizational success for IWS 1.0 and 2.0. Those factors are under the influence of the major program managers to varying degrees. The performance metrics must attempt to measure across the four balanced scorecard perspectives for IWS 1.0 and 2.0, not just programmatic and Fleet readiness, if they are to adequately support progress toward long-term goal achievement.

C. PEO IWS IS ON THE RIGHT TRACK

PEO IWS recognized at the outset of FY 2005 that it needed to improve its human capital strategy, horizontal integration, and performance metrics. Currently, the command has an active human capital strategy team that is further

developing and refining its human capital strategy. PEO IWS has also created a horizontal integration team to improve organizational efficiency by identifying redundant functions as well as areas that they can leverage organizational synergy to improve productivity. A performance metrics integrated product team is also actively pursuing PEO level metrics to better focus the organization's energy and measure results. They have leveraged expert facilitators to help achieve success in all three areas. Interestingly, this thesis recognized similar areas for improvement, but arrived at that conclusion by a completely different methodology. The three main areas for metrics improvement recognized by this research are human capital, teamwork (integration), and communication. These can also be the hardest areas to measure because of the difficulty in objectively quantifying performance in those areas, particularly in teamwork and communication.

As part of NAVSEA, PEO IWS was involved in an assessment by GENESYS Corporation regarding organizational alignment. The survey gave insight to the major program managers in six areas: Mission, Service, People, Processes, SEA POWER 21 and Transformation Framework. Each of the six factors could be further divided for analysis. People could be divided into Supervision; NAVSEA Leadership (Flag/SES); Job Skills & Knowledge; Performance Accountability; and Motivational Energy. The information was presented in such a way that users could determine how well aligned the employee and leadership perspectives were within the command. If it was apparent that there was poor alignment with leadership's goals then that might indicate the need for deeper investigation to determine the reasons for misalignment and an appropriate courses of action. At a minimum the survey might be used for trend analysis by the major program managers. It could probably prove a good indicator of communication and teamwork effectiveness, as well.

D. VALUE OF METHODOLOGY TO THE NAVY

The methodology used in this thesis, ethnographic interview and causal map creation, are an effective way to derive CPVs for an organization, and can provide a valuable starting point for a performance metric working group. As stated earlier, the best and most viable performance metrics usually come from a group effort within an organization. Selection of interview subjects is important so that the mapping process leverages tacit knowledge of individuals who know how the organization truly functions at both a strategic and tactical level. The presentation of the map to a metrics working group would be an excellent place to start that group's discussions. The group's time could be more efficiently spent working from the CPVs and outcomes identified by the causal performance map, or from a balanced scorecard or similar display of potential metrics. Large groups sometimes have difficulty agreeing on an initial framework and direction. The work done in arriving at CPVs should provide an initial framework for working group efforts and jump start the group toward a successful outcome.

The use of the causal map to derive performance metrics without the input of a stakeholder group is not recommended. The resulting metrics are potentially subjective and run a very great risk of missing an important element of the CPVs and outcomes.

E. POTENTIAL FOR FURTHER RESEARCH

Analysis of the success of a performance measurement system in a command that has recently reinvigorated its metrics might prove useful. There are currently many Navy commands revitalizing their measurement systems, just like PEO IWS. These commands provide opportunity for future analysis.

- Which methods for deriving metrics work best?
- Which specific metrics and types of metrics were least expensive to implement and track, both in time and money?
- What types of metrics were most useful to leaders and managers?
- Is there a measurable difference in performance before and after the implementation of the new performance metrics?

The Navy is operating in a long-term environment of fiscal constraint. There will continue to be a push for improved efficiency and effectiveness. Any research that can help commands make measurable improvements will be useful to Navy leaders.

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